Pit and Quarry

SAND-GRAVEL-STONE
CEMENT-LIME-GYPSUM

Pit and Quarry

Published Every Other Wednesday for Producers and Manufacturers of Sand, Gravel, Stone, Cement, Gypsum, Lime and Other Non-Metallic Minerals.

Subscription price $5 for 3 years; $2 for 1 year. Single copies 25c
Canadian and Foreign Subscriptions $1 additional for each year

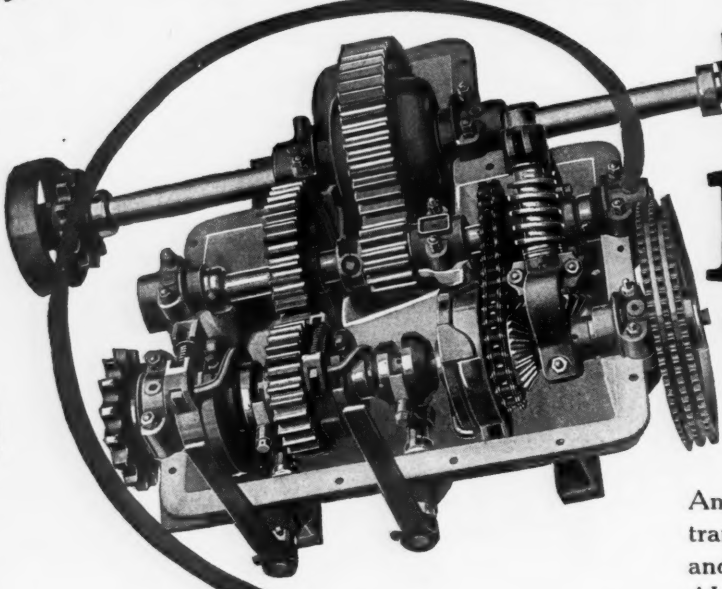
Vol. 14 CHICAGO, ILL., AUGUST 3, 1927 No. 9

FEATURE CONTENTS

Next Issue August 17, 1927

COMPLETE SERVICE PUBLISHING COMPANY
538 S. Clark St., Chicago, Ill.
Publishers of
PIT AND QUARRY and PIT AND QUARRY HANDBOOK

The HAISS CREEPER MODEL Loader has a LOADER Transmission



And in the NEW model 27 Loader the enclosed transmission case houses not only all the clutches and speed-charge gears (all running in oil) but ALSO THE SLOW SPEED WORM DRIVE.

There are other improvements (without any change in the fundamental Haiss design) of value to Loader users.

1. Engine power has been increased to 41 H.P.
2. Elevator chain (blocks), elevator and creeper drive sprockets and feeding propellers are now of MANGANESE STEEL.
3. The creeper tread mounting has been lengthened to further increase the stability of the machine.
4. The rigid-pivoted elevator is centered side-to-side and the feeding propellers balanced on either side of the foot of the elevator.
5. A nickel steel propeller-shaft, redesigned head take-ups, triple-strand engine drive chain—these are factors of larger life and lower upkeep.
6. The swivel discharge chute is now adjustable in its angle of discharge—to be set according to the nature of the material handled.
7. And among the NEW items is a NEW Catalog (No. 527) which should interest every man who is considering a Loader.

The George Haiss Manufacturing Co., Inc.
142nd Street and Rider Avenue
New York, N. Y.
Representatives Throughout the World

HAISS

Pit and Quarry

Vol. 14 CHICAGO, ILL., AUGUST 3, 1927 No. 9

FUTURE PROBLEMS OF THE CHEMICAL INDUSTRY

DR. CARL Bosch, Director General of the I. G. Dye Industry (the great German Dye Trust), recently published, in a supplement of the Frankfurter Zeitung, a study relative to the future problems facing the large scale chemical industry. The personality and the position of Dr. Bosch give added interest to the following viewpoints which he has presented in the above publication.

He states that the number of problems awaiting solution is considerable. Take, for instance, the great mineral chemical industry; the electrolytic production of caustic soda with salt as a basis faces this difficulty: How is one to find a large enough market for the chlorine resulting from the reaction? Within the same field, on the other hand, we have the new process for the production of sulphuric acid with gypsum as basis, which yields good cement as a by-product; this is an advantage all the more precious because the raw material is of national origin.

Within the field of products for washing and lixiviation (oxygenized acids with weak content of chlorine, sulphydrates, etc.) progress seems to have been achieved from the viewpoint of the preservation of fibers. Obtention of metals and metal salts with mineral and ores as basis must be prosecuted. Many difficulties are encountered in the treatment of poor ores or complex ores, that is to say, ores containing very different metals. In the field of light metals (magnesium, calcium, aluminium) the situation is developing favorably. But progress is still possible, for instance, in the treatment of argil (aluminium), in the securing of anhydrous magnesium chloride for the production of magnesium, in the preparation of caustic potash and even in the production of metallic sodium, a field that has been so thoroughly explored.

The matter of metallic alloys also presents problems that have not yet been solved. We must produce special alloys possessing either mechanical and very special mechanical qualities (for instance, the construction of motors) or exceptional resistance to high temperatures or chemical agents. By overcoming the action of rust by the use of nonoxidable steels or by coverings made of lakes as a basis it is possible to save millions each year. Within the field of iron and steel exclusively, much remains still to be done; with ore as a basis, we must produce the iron, not with the aid of coke, but by the help of reduction gases. This is a very important problem to be solved for the reason that it would enable us to realize a desire long since expressed for the securing of an iron free from all foreign matter such as, for instance, sulphur.

We have for a long time discussed the point as to in what measure metallurgy might profit by the use of oxygen instead of air. There can be no doubt that it would gain much thereby, but we still lack the means for producing oxygen at a low price so it may be used for that purpose and for other purposes of the same nature. Within the construction field much remains to be done: Production of special cements: protection of stone against atmospheric corrosion (smoke, soot). Chemistry for construction is only in an embryonic stage.

Before leaving the subject of mineral chemistry, attention should be called to a further problem that must be solved, that is, the manufacture of a substitute for natural mica, which plays an important role in electro-technical matters as an insulator and for which so far we have been unable to find a substitute. It should also be possible to produce a less brittle and more flexible glass for automobile windshields and panes. Recently much progress has been made in the use of phosphorus. By an electrothermal reaction we have secured the necessary phosphoric acid for agriculture in the form of soluble phosphates.

In the field of synthetic nitrogen we have obtained a provisional result by the production of ammonia under high pressure. We must now perfect the systems and methods for the production of various nitrogenous fertilizers derived from ammonia and advance our knowledge relative to the exact use and effects of simple or mixed fertilizers. The matter of complete, very concentrated and very soluble fertilizers is receiving particular attention; products of superior quality have already been obtained.

Passing on to the question of organized chemistry, we are facing the problems of fuels, coal and others. We are now dealing with the more rational utilization of coal and other fuels. We must eliminate soot in combustion; we must secure a proper gasification for gases that may be burned or otherwise utilized; we must purify these gases perfectly, and especially eliminate sulphur from them; and we must create motors that will burn dust, etc. We must again study methods for the greater rational use of by-products: tars and derivatives, hydrocarbides, phenols, etc. We are at the beginning of progress looking to the conveyance of gas over long distances.

One of the most important questions that we face with regard to the more rational use of coal is all of its liquefaction, that is to say, its transformation as far as possible into liquid fuel, and especially into gasoline. On this matter, the German Dye Industry, continuing the work of Bergius, has been experimenting in a new and larger laboratory, with its own process. We feel confident that it will furnish an economic yield. But the problem of coal in the general meaning of that word will not be exhausted when by its liquefaction we shall have been able to produce gasoline; the synthesis of methanol effected by the German Dye Industry shows that we are dealing with nothing less than with the resumption, from a new point of view, of all the chemistry of coal compounds and especially the aliphatic compounds, such as acetic acid and glycerine. Catalysis is the magic wand with which we are likely to create new transformations.

Nor is the field of wood chemistry far from being exhausted, either in theory or in practice. For the securing of cellulose with wood as a basis, much progress still remains to be accomplished; the same applies to textiles, rayon, rubber, etc. As for dyes, there can be no doubt that the pre-war supremacy of Germany in regard to the chemical industries has been deeply shaken. But much still remains to be accomplished, and this is especially true with regard to the very processes for manufacturing colors and lakes.

The popular impression has it that in the pharmaceutical field we have too many rather than too few products. The physicians themselves are nonplussed in the presence of the multitude of products offered to them and are unable to separate the good from the bad. In fact, the progress within the last few years has been considerable and yet the number of problems still left to be solved is beyond our present conception.

In particular we face the study of the nature of the active substances contained in the numerous glands, the discovering of remedies against tuberculosis, cancer, and grippe. As substitutes for the narcotics now being used (morphine, cocaine) we must find other synthetic products possessing the beneficent properties of these alkaloids without their detrimental reaction upon the nervous system. We must also discover medicine more particularly adapted for the use in tropical countries, against the tse-tse fly, the sleeping sickness, etc. With regard to elementary chemistry, the chief problems concern the preservation of food products. We are now even able to envisage the chemical production of albumin which would be a food for cattle. Struggle against plant diseases and parasites is another task facing the chemist.

This summary of Dr. Bosch's article reveals the complexity and variety of problems faced by the chemical industry and shows the vast field of theoretical studies and practical realizations awaiting it.

TRADE SLUMP IS SEASONAL

DEVELOPMENTS of the last few weeks tend to confirm the general view that the current recession in business activity is largely due to the seasonal influences that usually cause moderate curtailment at this time of year, according to the issue of the Guaranty Survey published by the Guaranty Trust Company of New York on July 25th.

"Since 1923 the decline in general industrial operations and trade volumes between spring and summer has been so regular and so pronounced that many observers have hesitated to regard it as a purely seasonal swing. The suggestion even has been advanced that increased industrial plant capacities, larger credit resources, better transportation facilities and a modified distribution of income have combined to accelerate the response of business activity to changing conditions, so that the long and violent fluctuations that formerly constituted the so-called business cycle have, for the time being at least, been transformed into a series of semi-seasonal, semi-cyclical adjustments.

"Whether this view be accepted or not, it must be admitted that there are few factors in the present situation on which to base pessimistic views as to the near future of business. Most of the conditions that might be mentioned as possible unfavorabie influences, such as speculative activity in the security markets, large borrowings on security collateral, low earning power in coal, petroleum, copper and other industries, declining commodity prices, narrow profit margins in many branches of industry and trade and the unsettled state of international finance, are not new developments and in some cases show definite improvement during the recent past. On the other hand, it may be pointed out that domestic financial conditions remain strong, that operations in numerous industries are unusually well sustained and that the active movement of commodities is distinctly encouraging."

CALIFORNIA'S NEW PORTLAND CEMENT PLANT COMPLETED AND NOW IN OPERATION

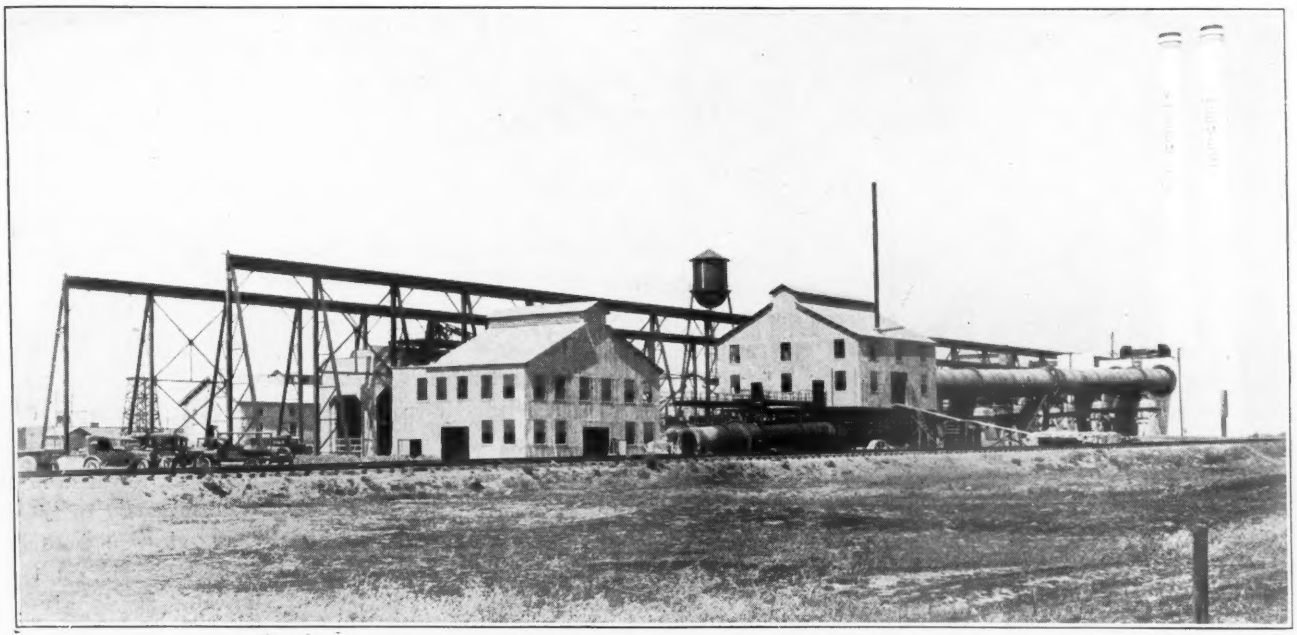
STACKS, slurry tanks and storage silos may be seen for miles from the railroads and the inland route of the State Highway near Merced, California, along the center of the thriving San Joaquin Valley. These stacks, tanks and silos, so noticeable from a distance, are the property of the Yosemite Portland Cement Corporation of Merced, California, and are part of its new modern wet process cement plant which has been producing cement only since July 23rd. The plant is located two and one half miles northwest of Merced n the center of Joaquin Valley.

It has been conservatively estimated that more than $3,000,000 is leaving the San Joaquin Valley annually for cement. A recent survey shows that the Valley is consuming 3,000 barrels of cement per day. This fact is behind the new plant of the Yosemite Portland Cement Corporation. The company is owned by people of the San Joaquin Valley. Here we find home capital invested to serve a home market. Even the electricity is a home product as it is purchased from the San Joaquin Light and Power Corporation. The San Joaquin Valley is the largest and most fertile agricultural area in California. It lies between the Sierra Nevada Mountains and the Coast Range and extends from the Tehachapi Mountains northward to Stockton. This area is about 60 miles wide and 250 miles long. The future water power developments in this region promise an increasing market for cement in the future. The plant was conceived several years ago but lack of finances held the project up until A. E. Wishon, vice president of the San Joaquin Light and Power Corporation, stepped in and purchased the property and holdings. The present Yosemite Portland Cement Corporation resulted. The present plant with a capacity of 2500 barrels per day followed in the natural course of events.

Limestone is obtained from quarries about sixty-two miles distant from the mill at Emory, a point in the Merced River Canyon on the line of the Yosemite Valley Railroad, which delivers the rock to the plant. Emory is only a few miles west of the entrance to the National play ground. The deposit covers between four and five hundred acres. The limestone ledge lies north and south and has a dip of 85 degrees to the east. The deposit outcrops over a hill for a half a mile and to a height of several hundred feet. The quarry opening is at an elevation of about eight hundred feet above the

Unusual Deposit. Quarry incline, railroad, storage bins and quarry in upper center

The Two 10 by 240 foot Kilns with the Two Concrete stacks in the Background. Each kiln has one of these stacks, which are 10 feet in diameter and 202 feet high.

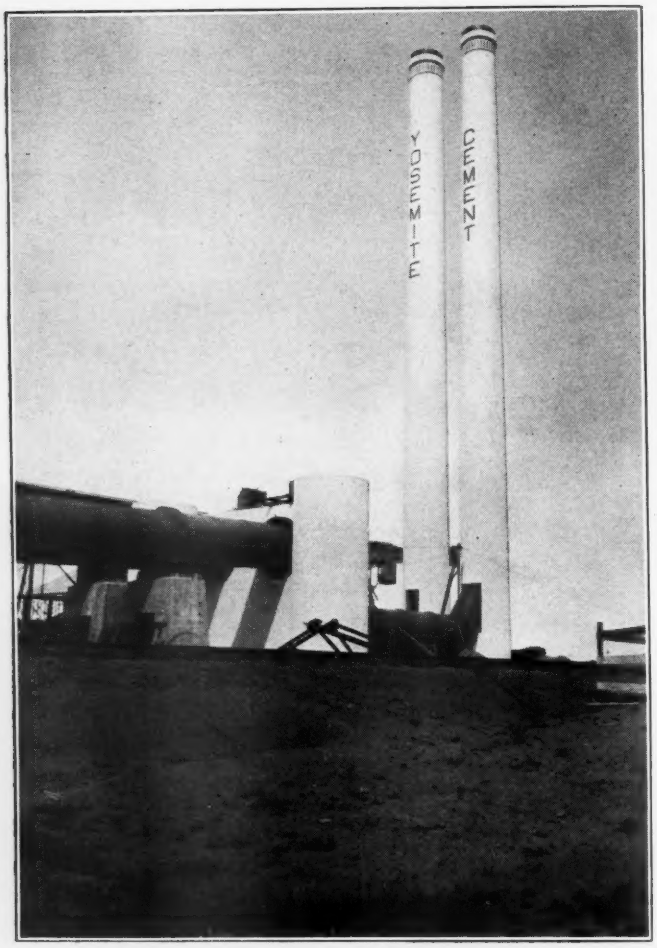


General View of Burner Building and Finish Mill

line of the Yosemite Valley Railroad. At this point it is possible to open a face 3000 feet in length with a possible future height of 500 feet. The limestone at this point lies at an angle of approximately 80 degrees from the horizontal and the quarry opening is on the upper or hanging wall side. This makes an ideal condition from a safety standpoint and at the same time will reduce the powder cost to a minimum. Practically no stripping will be necessary and the waste will be a minimum.

Drilling is done with Ingersoll Rand jackhammer drills and air is supplied by two Ingersoll Rand air compressors, each with a capacity of 640 cubic feet per minute. The stone is loaded by a 1¼ yard number 32 Marion electric shovel into 6 yard standard gauge railroad cars and hauled by a 14 ton Plymouth gasolene locomotive to an Allis Chalmers 30 inch gyratory crusher for reduction to eight inches. The primary crusher receives the material direct from the quarry cars and discharges to a 12 foot Traylor "Sheridan" grizzly. The crushing plant is located about 2000 feet from the quarry on the side of a steep hill. The grizzly takes out all material under one inch and discharges the oversize into a Williams number 6 heavy type Jumbo hammer mill crusher which is set to deliver

Trestle Conveyor for Rock

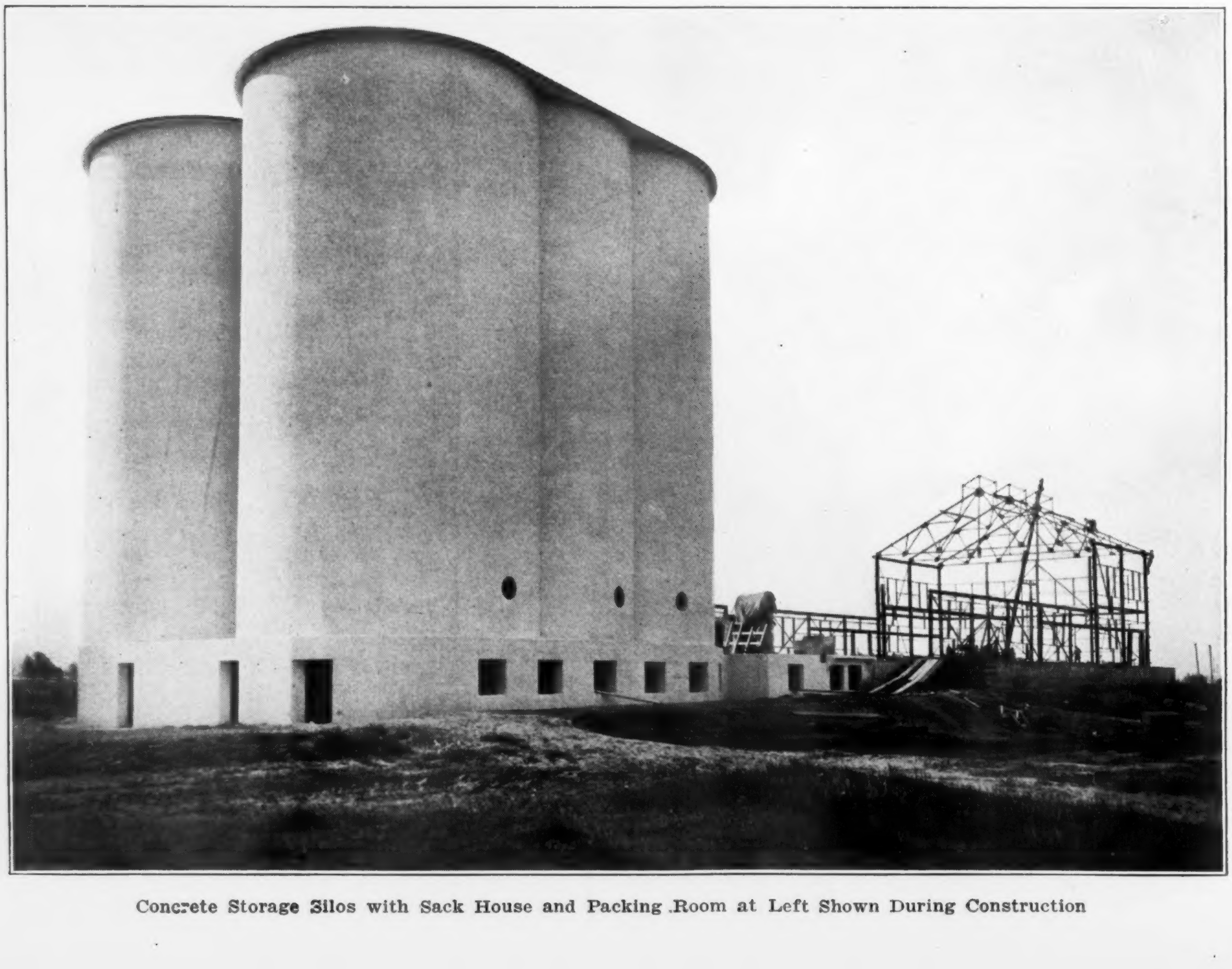


Stacks and Kiln Connection

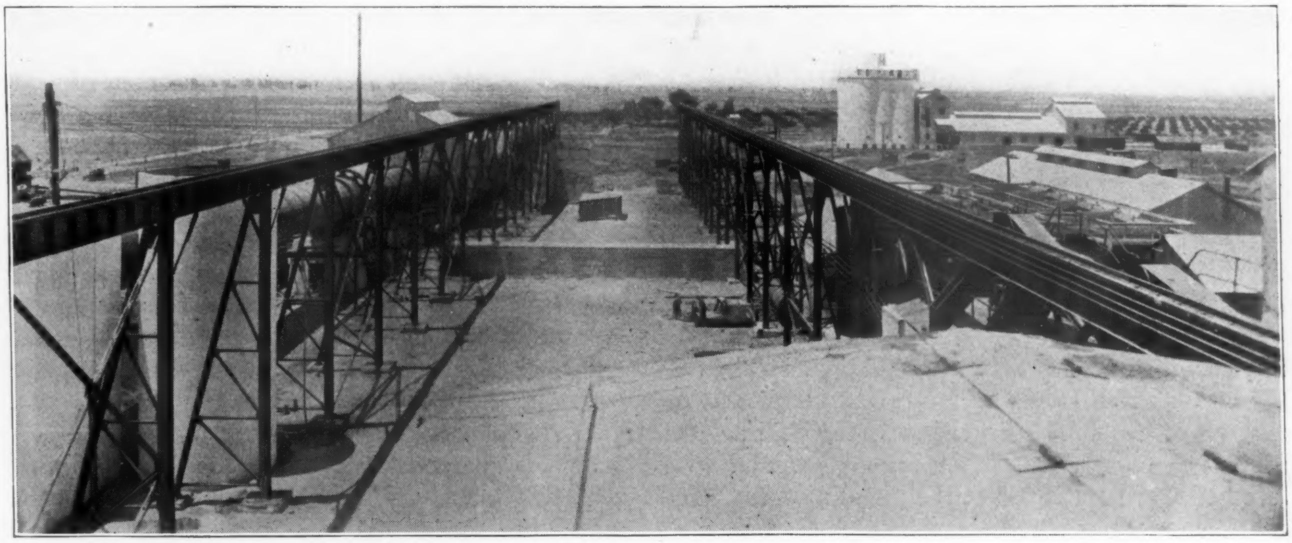
rock one inch and under. The rock is discharged from the Williams mill to a 30 inch belt conveyor and carried to a 600 ton storage bin.

Twenty ton cars are loaded from this storage bin and lowered to the main railroad level by means of a Wellman Seaver Morgan tandem driven hoist. This hoist is placed above the bin. A 1⅜ inch steel cable is wound around two grooved winding drums ten feet in diameter. The two ends of the rope are attached to the incline cars, one on each track. This inclined hoist is operated by compressed air and driven by a 200 h.p. direct connected electric motor. When a loaded car is being lowered an empty car is being drawn up, as the hoistway is a double track arrangement. The 200 h.p. motor gives enough power to raise supplies and machinery to the quarry level when necessary. It also acts as a brake during the time the loaded car is on the steepest part of the incline. Compressed air is furnished by an Ingersoll Rand compressor driven from the hoist. The cars are handled at a speed of 500 feet per minute. The incline is at a 38 degree angle for about 1000 feet down from the crushing plant and then it changes to a 10 per cent grade for the remaining 1000 feet to the lower terminal. At the lower terminal the rock is automatically discharged into a 300 ton bin from which railroad cars are loaded directly.

A stiff leg derrick of structural steel with an 80 foot boom and a lifting capacity of 20 tons has been



Concrete Storage Silos with Sack House and Packing Room at Left Shown During Construction



Traveling Craneway 70 feet wide and 595 feet long. Raw material, gypsum and clinker are stored here

placed to service the crushers, hoist and storage bins. Supplies brought up the incline will be lifted by the derrick directly from the incline track to the quarry. Clay is brought to the plant from a deposit one and a half miles from Carbondale near Merced over the Southern Pacific Railroad. The deposit consists of some 600 acres with a depth of 20 to 30 feet. The clay has a very high aluminum content and is of an extremely plastic nature, breaking down without any appearance of grit. It is ideal for the manufacture of cement as well as being adaptable to and sought for by the ceramic industry. The clay is loaded into trucks by means of team drawn scrapers and then shipped by railroad to the mill. It arrives at the plant on the same track as the limestone and is unloaded in a similar manner.

The plant site was selected with relation to the distribution of the finished cement rather than with relation to the raw materials. The plant property covers 147 acres and is served by three railroads, the Southern Pacific, Yosemite Valley and Santa Fe. The entire layout and all installations have been made to allow for easy expansion. The plant can be doubled in size without interference of operation and at a minimum of expense.

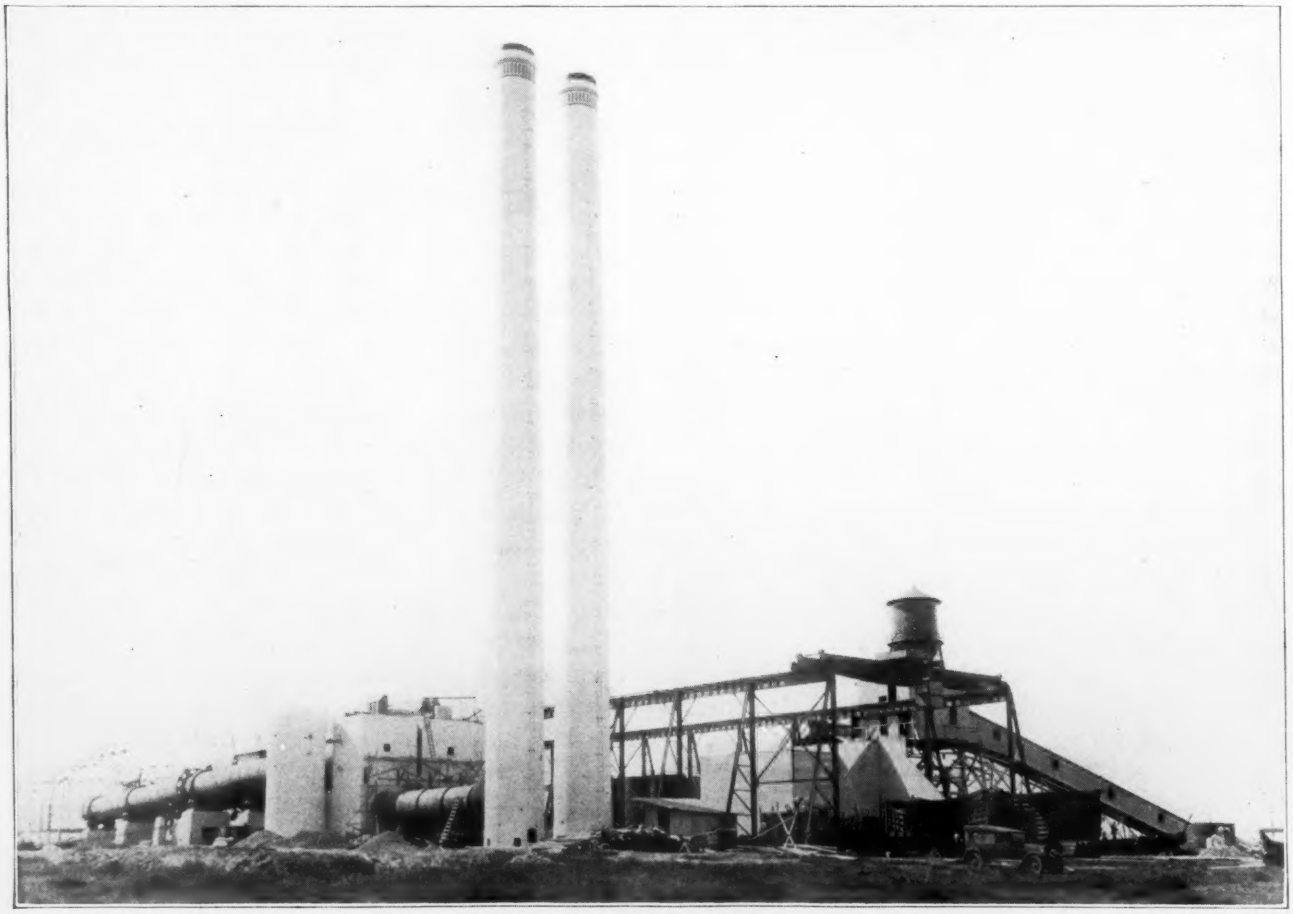
Raw material comes into the plant on tracks running parallel to the length of the mill. This track is elevated to provide a dumping pit under the cars without the necessity of an underground pit. Upon arrival at the plant site, the rock and clay are unloaded from the bottom dump cars into the dumping pit or pocket, from which a 24 inch belt conveyor carries the rock to the Allis Chalmers raw compeb mills bins and the clay to a 26 foot Allis Chalmers wash mill. Any surplus of either material is bypassed to a point under a Northern bridge storage crane. This crane, is one of the unique features of the mill. It has a 70 foot span and is approximately 600 feet long and is equipped with a three-yard Erie clamshell bucket. It runs parallel to the kilns, thus making it possible for one crane to handle clay and rock, in and out of storage, clinker in and out of storage, and also unload the gypsum from the cars and feed it into the gypsum bins in the finish mill. The storage capacity for raw material is 35,000 tons of rock and clay, 100,000 barrels of clinker, and several thousand tons of gypsum. This bridge crane has a 10 ton lifting capacity, is 70 feet wide, 580 feet long and has a 30 foot clearance and a bridge traveling speed of 500 feet per minute. The supporting structure is of steel.

The raw mill equipment consists of two Allis Chalmers three compartment wet compeb mills, 7 feet by 26 feet, driven by 500 h.p. A. C. 440-volt motors, directly connected by magnetic clutches. The slurry is pumped from the raw compeb mills into twelve slurry storage and correcting tanks. Each of these tanks has a capacity of slurry equal to 400 barrels of finished cement. These tanks are arranged so that the slurry may be drawn from any number of them at the same time and again pumped back into any of the twelve tanks, or it may be pumped into either of the two concrete kiln feed tanks, which have a capacity of 800 barrels each. All slurry tanks are air agitated.

Two Allis Chalmers rotary kilns are being used. Each kiln is separately driven by a variable speed motor and is supported on four tires. A Ferris wheel feeder, direct connected to a variable speed motor that is operated from the burning end of the kiln, regulates the kiln feed. Each kiln has a concrete brick lined stack with an inside diameter at the top of 10 feet. A long horizontal flue between the kiln and stack serves as a dust collector. All dust is collected by a screw conveyor and elevated directly into the kiln feed pipe. Crude oil is used for firing the kiln. The oil is stored in an underground concrete reservoir of 8,000 barrels capacity. This reservoir is constructed so that the cars may be unloaded by gravity. Oil is received in tank cars which discharge the oil into a concrete trench from which the oil flows by gravity to storage. A pump delivers the oil to the kiln. The oil is heated by steam. For atomization, oil at two pounds pressure is used. One burner is used for each kiln and adjustments permit changing the direction, width and length of the flame easily. Both kilns are followed with an 8 by 100 foot Allis Chalmers cooler from which the clinker will be carried by a cross belt conveyor to a double elevator, one being used as a stand-by. These elevators lift the clinker to the finish compeb mills bins or by pass to storage as may be required. This arrangement permits delivering all of the clinker to the grinding mill bins or to storage or any proportion can be mixed with stored clinker as it is fed to the grinding mills. The cooler hood is specially designed and is supported on wheels similar to a kiln hood. It is made with a structural steel frame lined with fire brick and fits close to the cooler end and snug with the kiln firing floor, giving a practically airtight connection between the kiln and cooler.

The finish mill is equipped with two 7 by 26 Allis Chalmers compeb mills driven by the same size motors as those on the raw mill. These mills discharge to a cross screw conveyor which delivers the cement to a Fuller Kinyon pumping system. This Fuller Kinyon pumping system delivers the cement through a 600 foot pipe line to the stockhouse. The stockhouse has a capacity of 6,000,000 barrels of cement and consists of four concrete silos each 32 feet in diameter and 60 feet high. It has one star bin and three interstice bins. Debinning is accomplished by means of screw conveyors which deliver to a bucket elevator discharging to bins over the Bates packers. Provision has been made for four 3 tube Bates packers and two packers have been installed for the present. The two Bates packers discharge to a common belt conveyor which loads directly to cars from both sides of the packhouse. Adjoining the packhouse and between the loading tracks is the bag storage and cleaning building, which is 54 by 152 feet. Under the gypsum bin are two specially designed gypsum feeders each of which discharges into a separate screw conveyor that delivers the gypsum to the feed end of the mill. The screw conveyor is driven by the grinding mill and the feeder is driven by the screw conveyor.

All the mill buildings are structural steel frame covered with galvanized iron sheets. They are provided with windows and ventilators. The motors are 3 phase, 440 volt, 60 cycle alternating current units. With the exception of the kiln and cooler drive, all motors are direct connected through herring-bone speed reducers. The necessary switching equipment is located in each department for motor control. The engineering work on the plant was handled by the Stevenson Engineering Corporation. The plant was designed and laid out so that

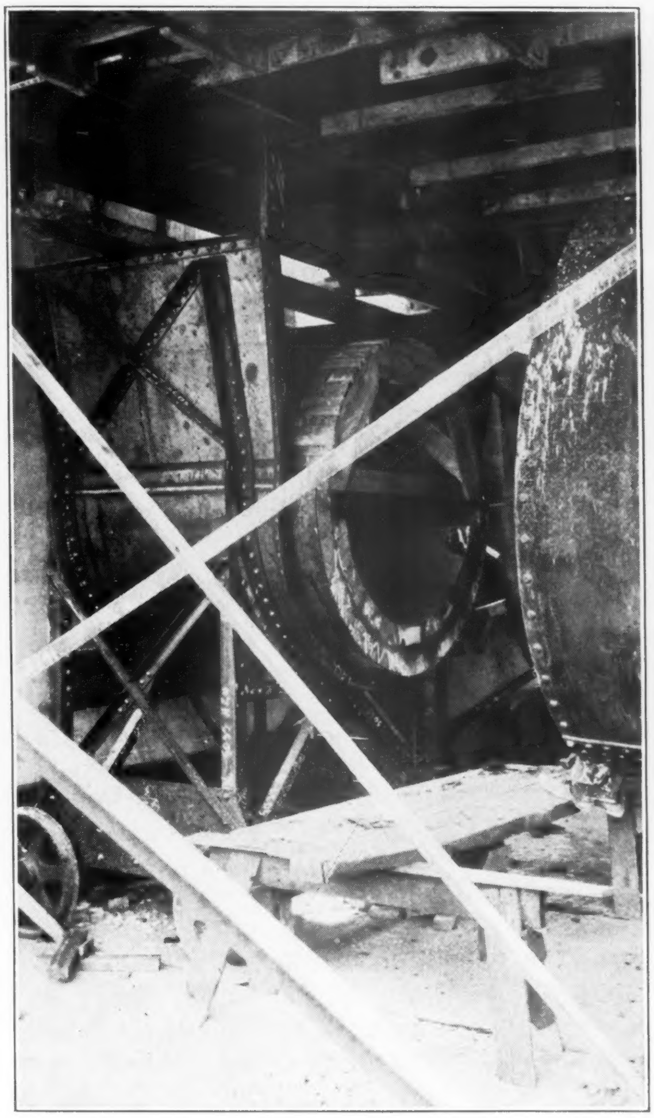


General View of the Mill Unit

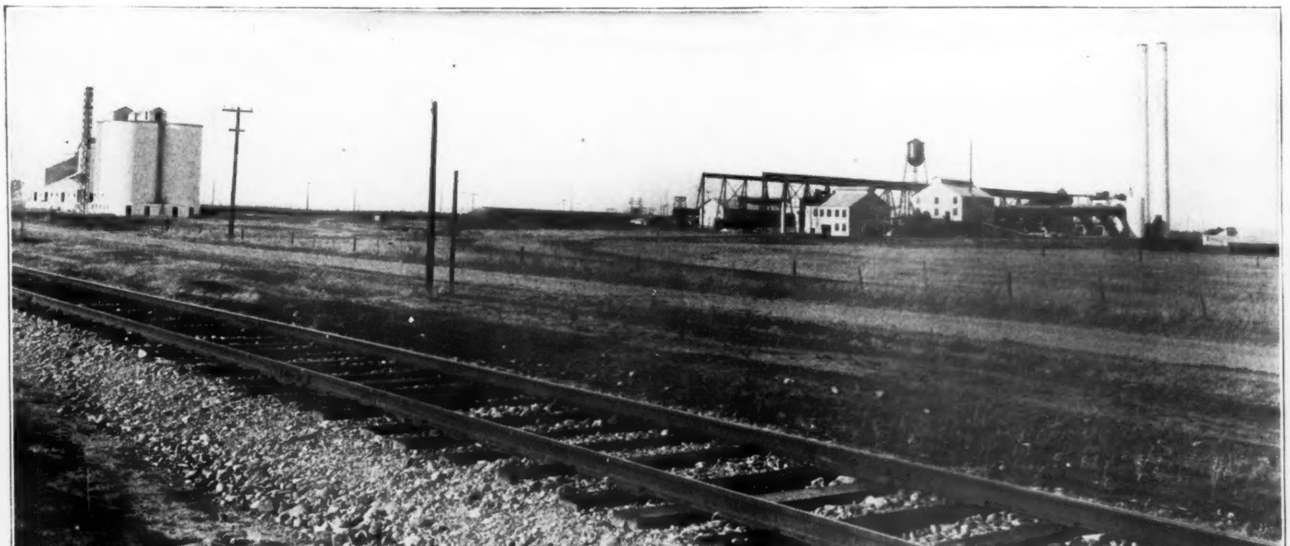
the capacity may be doubled or trebled without any interference whatever with the daily operation of the present units. The concrete bins were built by the MacDonald Engineering Company.

A. R. Wilfley and Sons supplied the 200 barrels per hour slurry pumps for the raw grinding department and for the kiln feed and also the 500 barrel per hour slurry pump for pumping to the kiln feed tanks. These pumps are direct connected to driving motors and supported on a common base. The Pacific Gear and Tool Works furnished the herringbone speed reducing units with basis for connected motors, the main switchboard, the motor control switches and all the motors except the 500 h.p. synchronous units. The Weber Chimney Company built the 200 foot concrete stacks. The Northern Engineering Company furnished the 10 ton bridge crane with the 440 volt 3 phase 60 cycle alternating current motors. The traveling speed of this bridge crane is 500 feet per minute, the hoisting speed 100 feet per minute and the trolley speed 200 feet per minute. The Worthington Pump and Machinery Company supplied the 4 by 6 inch Dean triplex oil pump which is direct connected to a motor. The Allis Chalmers Manufacturing Company supplied the clay wash mill, wet grinding mills, dry grinding mills, 500 h.p. synchronous motors, crusher, kilns and kiln feeders.

The gravity tramway hoist was furnished by the United Commercial Company. The speed of the 20 ton cars is 2200 feet per minute on a 45 degree incline. The tram is 4500 feet long. Moloney Electric Company supplied the transformers. The Western Pipe and Steel Company furnished all the structural steel, steel chutes, craneway, gypsum bins and a hemispherical bottom tank of 50,000 gallons capacity. Lumber was supplied by the Merced Lumber Company and the Cross Lumber Company. Pioneer Rubber Mills supplied the belting. Grind-



Showing the Cooler Feed End Hood Pushed Back for Lining



View of Plant at Right. Concrete Storage Silos Shown at Extreme Left. Tracks in the Foreground Belong to the Yosemite Valley Railroad.

ing balls were furnished by the Jeffrey Manufacturing Company and the Pennebacker Company. Bodinson Manufacturing Company furnished the conveyor and elevator equipment. Hercules and giant powder is used. Kyle and Company supplied the reinforced steel bars for concrete work and all the corrugated iron used in the buildings. General Refractories fire brick is used in lining the kilns.

Construction and installation work was handled under the direction of George A. Fisher, superintendent with the Stevenson Engineering Company, and H. K. Fox, engineer with the San Joaquin Light and Power Corporation. Mr. Fisher will continue in charge of plant operations. The officers of the Yosemite Portland Cement Corporation include A. E. Wishon, president; W. A. Sutherland, vice president; Murray Bourne, secretary, and A. N. Jacobs, treasurer. D. A. Schlemmer is sales manager.

A. Emory Wishon has been a pioneer in the electrical development of the San Joaquin Valley, having been a valley resident since childhood. He is a graduate of the Missouri School of Mines. He returned to the valley as manager of the Coalinga Water Company nearly 20 years ago, and with it as the neucleus organized the Midland Counties Public Service Corporation which took over numerous independent electrical properties that now serve the southwestern section of Fresno county and Monterey, San Luis Obispo and Santa Barbara counties. From this work his rise was rapid. Today he is vice president and general manager of the San Joaquin Light and Power Corporation, the Great Western Power Company of California and the Midland Counties Public Service Corporation. He is also a member of the board of directors of the California Development association and is its San Joaquin valley regional vice president.

The name of W. A. Sutherland has been prominently associated with law and banking in the San Joaquin Valley for a quarter of a century. Formerly he was a member of the widely known law firm of Short and Sutherland of Fresno. He retired from general practice a number of years ago to become vice president and general manager of the Fidelity Bank of Fresno, now a part of the Pacific Southwest chain. He is now chief counsel for the bank, and is connected wtih numerous San Joaquin valley corporations.

Murray Bourne is general counsel for the San Joaquin Light and Power Corporation and the Midland Counties Public Service Corporation. Mr. Bourne has been connected with both organizations as an attorney virtually since his coming to California from Vermont 15 years ago. He is also a director of the Fresno Building Corporation and president and director of the Twenty-one Oil Company, owning a large acreage in the new fields of western Fresno county. A. Emory Wishon and W. A. Sutherland are also on the directorate of this company.

George A. Fisher is recognized as one of the outstanding technical men of the cement industry on the Pacific Coast. Mr. Fisher has had supervision of construction of the Yosemite plant and will continue as superintendent of operation. He is a graduate of Alabama University. Mr. Fisher has spent his entire professional life as a cement specialist. He was connected for years with the old A. A. mill at Oglesby, Illinois, coming to California in 1907 to manage the California Portland Cement Company's mill at Colton. Leaving this position he entered the service of the city of Los Angeles and built the giant plant at Monolith, in the Tehachapi mountains. Following this he became manager of the "A" and "B" mills of the California Portland Cement Company, then was general superintendent of operation for the Riverside Cement Company, and after leaving here and engaging for a time in private engineering assumed the operative management of the Monolith mill. He was at this plant for several years, leaving to join the Stevenson Engineering Corporation of San Francisco as a cement engineer. It was from this latter organization, which acted as consulting engineers on this newest project, that Mr. Fisher came to the Yosemite Portland Cement Corporation.

Labor Pledged to Cut Cost and Eliminate Waste

The tremendous savings and cost reductions possible in manufacturing were discussed at a conference called by the Philadelphia Labor Union and the Philadelphia Labor Institute. William Green, President of the American Federation of Labor, pledged the co-operation of labor in every attempt to reduce waste but declared that the resulting benefits should show proportionately in high wages as well as increased profits. He said:

"Waste in industry may be divided into three classifications—material waste, human waste and spiritual waste. Labor has given most careful thought to each of these qualifications, putting emphasis upon the human and spiritual rather than upon the material classification. Material waste in industry greatly affects the economic life of the workers. As waste detracts from the earnings of industry, so it detracts from the wages of employees. The difference between industrial success and industrial failure is many times found in the wasteful processes which often attend industrial operations. So long as industry is only partially efficient, labor believes that the wages paid can be substantially increased through an increase in industrial efficiency and the elimination of waste. By the same process the cost of manufactured articles to the public can be materially reduced."

POROUS CONCRETE

METHODS OF MANUFACTURE, USES AND APPLICATION

By Herman E. Wennstrom
Staff Writer, Universal Trade Press Syndicate

THERE are two principles which have been utilized in the production of porous concrete. The first depends upon the generation of a gas during the process of setting brought about by a chemical reaction resulting from the action of certain ingredients in the cements in combination with water upon certain added materials. The latter must be of such a nature that a gaseous substance results from their interaction with water, generally in the presence of alkalis or alkaline substances. As examples of materials of this type may be mentioned: certain metals in a fine state of subdivision, such as zinc, aluminium, magnesium, calcium, etc.; furthermore, carbides of a type which undergo a slow decomposition in contact with water, such as aluminium carbide.

The second principle involves the use of a substance which is solid at a low temperature but liquefies with the rise of temperature, allowing the cements to form an outer coating while in the solid state and of such a nature that when it assumes the liquid phase it enters into chemical combination with the cements. A substance of the type is water, employed in the form of ice. Hence the product obtained by the application of this principle has been termed "ice concrete," whereas what is obtained by making use of the first principle is spoken of as "gas concrete."

Several patents have been granted in England in which the application of these principles is involved. One of these patents* puts forth the following claims, dwelling upon the fact that it has already been proposed to add to Portland cement ground burnt alum and slate ashes. The patentee states that porous cement or mortar products are obtained by adding to the cement or mortar in the dry state aluminum or a similar metal in a very fine state of subdivision, the object being to obtain an evolution of hydrogen before the cement or mortar hardens. The production of pores in the resultant mass occurs due to the passage of the gas through the material while in a plastic condition and suggests the employment of hot water or the addition of a small amount of caustic alkali in order to accelerate the evolution of the gas, the mortar being prepared in the usual manner with or without the addition of sand.

The process consists of the addition to the cement of a mixture of so-called "slate-lime" and a powdered metal which is adapted to generate gas from the resultant mixture on the addition of water. Aluminium, zinc and magnesium are metals of this type. "Slate-lime" is an intimate finely divided mixture of calcined slate and lime, as for instance 50 per cent by weight of each or 60 per cent by weight of lime and 40 per cent by weight of calcined slate. The calcined slate and lime should preferably first be finely powdered separately and then ground together.

When the gas-generating metal powder is added to the cement together with the "slate-lime" the product obtains a high degree of porosity and a uniform composition which is due to the fact that the whole mass consists of a finely divided binding agent and water. The mass will thus not contain any particles which will sink to the bottom but only very light and fine particles which will remain uniformly suspended in the liquid mass during the hardening of cement; moreover, the "slate-lime" will not cause any saline efflorescence on the surface of the bricks made out of this mixture, as the calcined slate will bind any salts likely to cause an efflorescence. Furthermore, the addition of "slate-lime" is claimed to secure the advantage that the cement can be mixed therewith without reducing the strength of the product.

The introduction of a powdered metal of the type mentioned into the mixture of raw materials in very small quantities is generally made in amounts of less than one per cent. The introduction of the metal may be carried out at any stage of the incorporation of the raw materials; it ought to be ground together with the latter so that an intimate mixture is effected. When water is added to such a mixture, a chemical reaction takes place resulting in the generation of large quantities of gas which cause an increase of the volume of the mass. This takes place before the "binding" sets in, and when the material has been hardened "a porous stone-like material" is obtained.

The addition of lukewarm water of a temperature of from 87 degrees to 104 degrees F. is required in order that the reaction may take place more rapidly and that a larger quantity of gas may be produced. In order to reduce the period for the setting, it is convenient to add substances adapted to this purpose, such as sodium carbonate and so-called fused aluminous cement. This latter, which is known in France as "ciment fondu," is manufactured with a low percentage lime (about 40 per cent), while with ordinary cement a lime content of about 60 per cent is employed. The fused aluminous cement causes a very rapid binding (hardening) and should be added only in a very small quantity, for example 2 to 5 per cent.

*English Patent 212,419 granted to Johan Axel Erikson of Stockholm, Sweden, dated March 13, 1923.

Two formulæ as examples for the production of a porous concrete of the type under consideration are as follows: (1) 70 to 85 parts by weight of "slate-lime," 15 to 30 of Portland cement, 0.25 of zinc dust, and 50 to 100 of water. (2) 60 to 80 parts of cement, 40 to 20 of "slate-lime," 0.15 of aluminium powder and 40 to 80 of water.

It is claimed that the material manufactured according to this procedure has a high degree of porosity and that the pores are fully separated from one another by means of partition walls. On account of this fact air cannot circulate through the material, since the different cells containing the generated gas are wholly closed. The material has a very low weight for volume, the specific gravity being 0.5. Due to the high porosity of the material, relatively small quantities of raw material will suffice for its manufacture; furthermore, exterior walls, partition walls and other portions of structures erected with blocks out of this material become very light, and an advantage is gained of a simpler and cheaper building construction than hitherto available.

The material has large heat-insulating power, which makes it very suitable for use in the construction of exterior walls of buildings, and it is easily workable, capable of being turned out in the form of bricks, slabs and the like. It can be cut soon after having been manufactured; i. e., when the resistance is still low. This lends it conveniently to the production of bricks and slabs in the manner that large units be first turned out and these then sawed or cut to units of smaller dimensions, resulting in a reduction in costs in quantity production, besides attaining exactness in dimensions and smoothness of surfaces.

The second method or principle in the production of a porous concrete involving the use of water in the form of ice and resulting in the production of a so-called "ice concrete" is exemplified in a patent* calling attention to the fact that contemporary building materials of the type of cement, mortar and concrete have the disadvantage of being bad heat and sound insulators chiefly on account of their density. This makes their use disadvantageous except where employed for purposes of support.

One advantage of "ice concrete" over that of "gas" is that the former can be shaped in the course of manufacture, whereas the latter can be cut into desired forms only after it has hardened.

Furthermore, such porous building material as may be aptly termed "ice-concrete" is made by mixing snow, crumbled ice or artificial hailstones with some quickly setting hydraulic substance or material, such as, for instance, cement, mortar or plaster. This surrounds or coats and insulates the snow or ice particles used to produce the pores in the intended mass and at the same time this coating material prevents the snow or ice particles from melting too quickly, thus facilitating the tamping or pressing of the mass or pieces thereof into the desired shape. Should it be desired to mold the ice-concrete, water is added until the mixture becomes fluid, but not before the snow or ice particles have been coated by the hydraulic substance.

In case it be desired to use several different ingredients in forming the ice concrete, the snow or ice particles, after they have been coated or insulated in the manner described, can be incorporated with the desired materials in a proportion requisite to produce the desired effect. In a like manner, it will be possible to predetermine the size and quantity of the pores in the ultimate product by using a greater or a lesser proportion of snow or ice particles in the mixture. After all the ingredients have been well mixed together, the mass can be tamped or molded into pieces of the desired shape and size.

After tamping, pressing or molding the objects they are to be taken into a warm room, where the hardening can begin at once and where the snow or ice particles which are contained in the mass can begin to melt, giving the mass the humidity which cement, for instance, needs in order to harden. As the snow or ice particles coated with a hydraulic material meet the water which is partly absorbed by the mass and partly evaporates into the air, the mass becomes porous to the desired degree, because it cannot, even when in a fresh state, shrink, as this is prevented by the already hardened insulating layer which coats or encloses the snow or ice particles.

Considering the lightness of porous concrete and the small amounts of material required to produce a large bulk, it will, no doubt, prove an attractive and advantageous proposition in the production of certain types of building materials where low cost is a prime factor and where there is no demand for a high breaking strength. It seems to be an especially inviting material for the production of thin plates such as plaster or wall boards for mounting on studs in the construction of interior or partition walls. Porous concrete, being composed of permanent inorganic materials, offers an advantage, as, unlike paper pulp or wood fiber, it is not liable to decay or deteriorate, and, not containing any material capable of burning or of giving off combustible vapors on exposure to heat, it may be classed as a fire retardant. Furthermore, it might find application as a raw material in the production of various types of roofing, it being possible to effect a waterproofing of the surface by the application of suitable substances, inorganic or organic, according to the type of product desired. Another field in which it might be used is in the production of imitation tile.

*English Patent 221,742 granted to Viktor Wikkula of Helsingfors, Finland, dated September 18, 1924.

GREAT GATHERING OF NEW YORK PRODUCERS INSPECTS NEW DOLOMITE PRODUCTS PLANT

By H. W. Munday

ROCHESTER, New York, was the scene of much activity on Friday, July 22nd. Trains arriving on the morning of that day brought producers from all parts of New York State and some from other states. The highways also were dotted with automobiles with Rochester as their destination. The occasion was the mid-summer meeting of the New York Crushed Stone Association. A big outing had been planned, the new plant of the Dolomite Products Company was to be inspected and several officers of the National Crushed Stone Association were expected. By eleven o'clock the offices of the General Crushed Stone Company and the Dolomite Products Company were jammed.

Everything was arranged in splendid fashion except the weather but, as it happened, the rain did not dampen the enthusiasm that proved to be such a factor of the proceedings. The entire program had been arranged by George E. Schaefer, president of the New York Crushed Stone Association, and John Odenbach. At eleven thirty the various groups met for lunch at the Odenbach Restaurant. One o'clock ended the lunch and all adjourned to the new plant of the Dolomite Products Company for a two hour inspection visit.

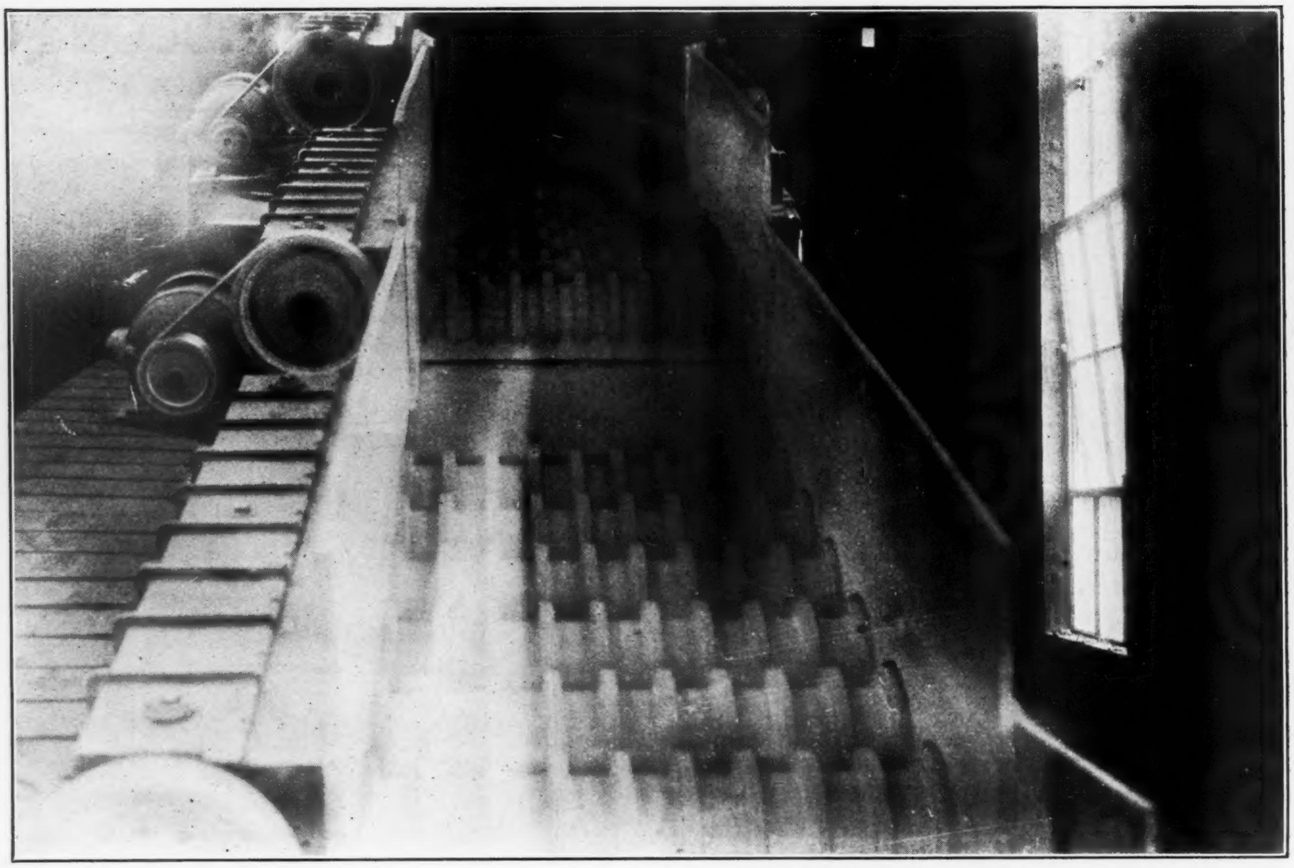
Dolomite Products Company has come to be known throughout the crushed stone industry for doing things differently. Attention was first directed to the operations of this company when gas was discovered on their plant property; then again, when they did some pioneering in the use of trucks for hauling stone from the quarry to the primary crusher. Now we find them doing other things differently, particularly in the matter of screening.

Before we discuss the new plant let us consider the most important factor in the Dolomite Products Company, John Odenbach, president. Those who know the history and details of the Dolomite

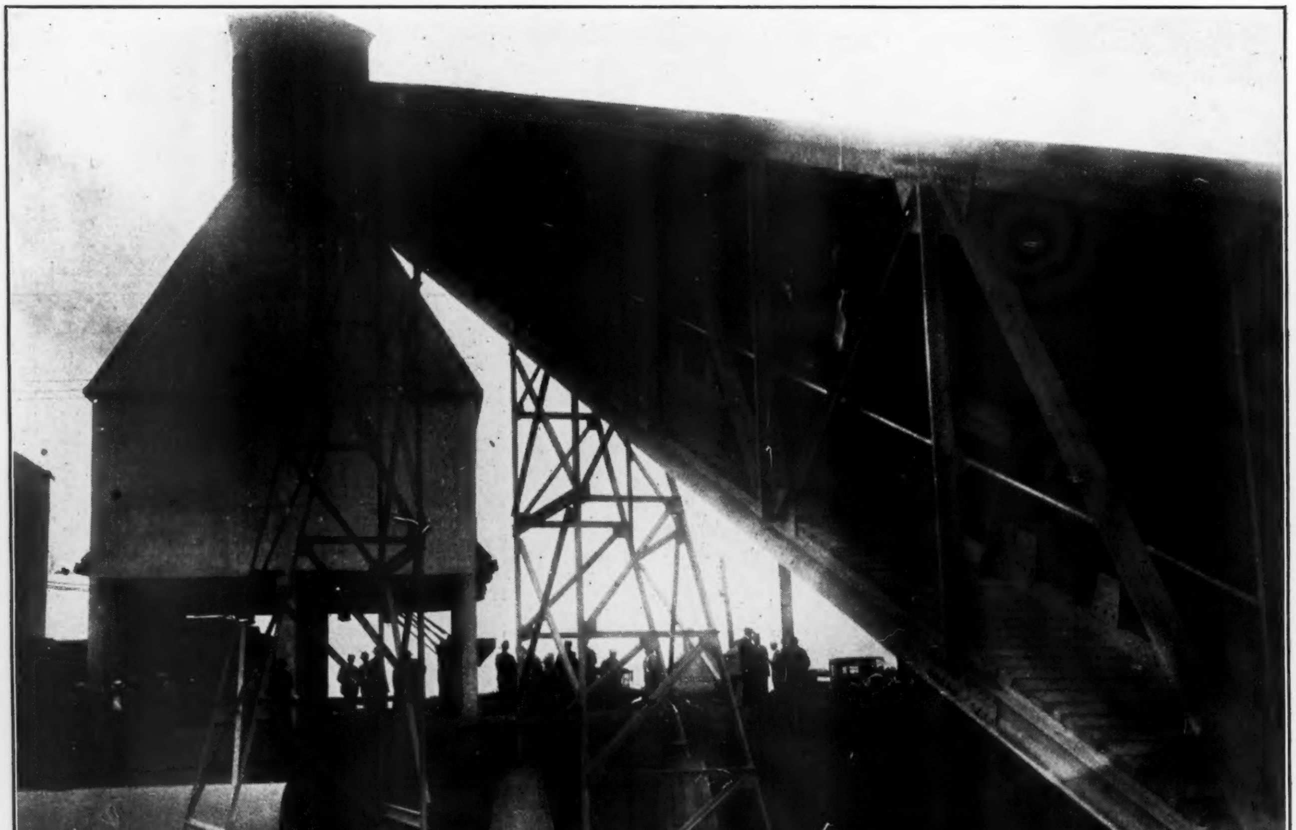
John Odenbach

Products Company will agree that John Odenbach is the most interesting factor in the entire unit. We only have to go back to the World War and we find John Odenbach in the restaurant business. He was successful and enjoyed the friendship of many leaders in Rochester. The name of Odenbach was and still is known to practically every resident of

Portion of Quarry Operated by Dolomite Products Company



Specially Designed Rotary Manganese Steel Grizzlies



Belt Conveyor to Screens Over Bins. Note Groups of New York State Producers Grouped Around

Rochester. The close of the war brought new business conditions to John Odenbach and he was restless. He looked around for a new interest and picked on the crushed stone business, probably because he knew the least about it of all the enterprises available. He found a plant close to town on the Buffalo Road. After studying the deposit and layout he decided to buy. With a few associates he took over the plant and organized the Dolomite Products Company. From the start he became keenly interested. Being of a mechanical turn of mind he studied the practical problem of operating a crushed stone plant. The plant as it stands today is his own work. Engineers had no part in the program of development. John Odenbach has succeeded in completing one of the simplest and most efficient crushed stone plants in the industry. Some of the outstanding features of this plant are: (1) trucks are used to transport the stone from the quarry to the primary crusher, (2) bucket elevators are not used anywhere in the plant, (3) special rotary grizzlies do all the screening, (4) a force of sixty-two men including truck drivers produce 2500 tons of stone per day, (5) a night force is operated about eight months in the year at a decided profit, (6) no revolving cylindrical screens appear in the plant and (7) a practically noiseless screening system is used.

While a study of the plant shows conclusively that John Odenbach is inventive and resourceful, a closer study of the man and his employees and associates shows that he is also generous, appreciative, understanding and just. These latter qualities are a more important factor in the success of the Dolomite Products Company than an inspection trip such as was arranged would reveal. Few men in the crushed stone industry have a keener sense of honesty, deeper appreciation of justice, more compassion or less bigotry than John Odenbach.

Many Cars Carried These Banners

One of the good fortunes of the Dolomite Products Company is an excellent quarry formation. The property covers 85 acres and has been tested with the result that there is known to be excellent dolomite to a depth of 140 feet. Along portions of the quarry there appears to be excellent stone for curbing purposes for a depth of about 12 feet. We

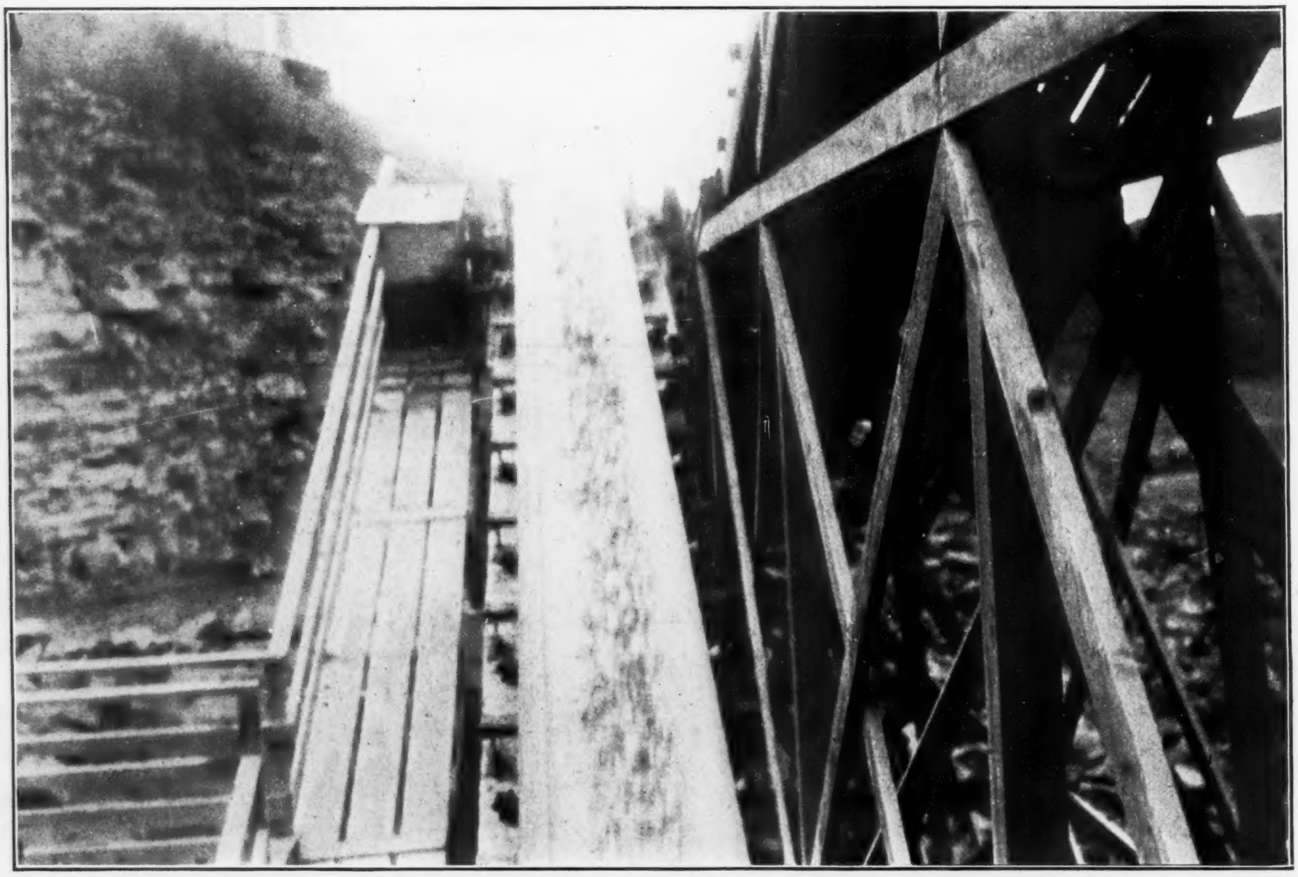

Truck Discharging Into Primary Crusher. Conveyor at Left Elevates Stone to Primary Grizzly. Building at Right is Housing For Conveyor to Screens Over Bins

can expect to learn that the Dolomite Products Company has branched out into this market sometime in the future.

At the present time a quarry face of 50 feet is being worked. The overburden averages about 4 feet. Two Sanderson well drills prepare the holes for blasting. Six inch holes are drilled and Hercules powder is used with Cordeau Bickford fuse. The quarry contains two different dolomites. The Gulf dolomite runs to a depth of about 14 feet and the Lockport dolomite runs to a depth of about 101 feet. Two Marion shovels are used for loading stone into the trucks. One of these shovels is a gas electric and the other an electric. Five trucks are used for hauling stone during day operations and four are used on night work. Both Mack and White trucks are used. The trucks have bodies designed and built by John Odenbach in the company's shop. They have tail boards that straighten out even with the body floor when the truck is in dumping position. This is a decided convenience when discharging to the primary crusher. The tail board is raised and lowered by means of a wire rope connection through a pulley. The truck bodies are electric welded throughout with rivets used only where the dumping mechanism is attached to the truck chassis. The haul distance of these trucks from the shovel to the primary crusher is a little more than 500 feet.

The primary crusher is a number 60 Allis Chalmers gyratory driven by a 200 h.p. Allis Chalmers motor. The discharge from this crusher is elevated by a 90 foot center belt conveyor that discharges to a second 90 foot centers belt conveyor that delivers the crushed stone to a primary grizzly. The oversize from this grizzly is discharged to a bin from which it is fed to a number 8 Kennedy crusher driven by a 100 h.p. General Electric motor. The discharge from the Kennedy crusher is picked up and carried over the same belt conveyors as the discharge from the Allis Chalmers gyratory crusher.

Material passing the grizzly drops to a hopper from which it is drawn and elevated by a 185 foot belt conveyor that discharges over a series of six specially designed rotary grizzly screens. These screens were designed by John Odenbach. The screens are three feet wide and six feet long. They consist of a number of manganese rolls, supplied by Taylor Wharton, which are perforated on the outside edges that revolve in the shaft. The large machines have six shafts and the small machines have ten shafts. The speed of the shafts for the large units runs from 75 to 95 r.p.m. while the speed of the shafts for the small machines runs from 95 to 125 r.p.m. Every bit of the 3 by 6 foot They have tail board that straightens out even with the large screening capacity. The screens are driven by 5 and 3 h.p. Allis Chalmers motors through a countershaft of worm wheels. The worm wheels in turn mesh into bronze ring gears mounted



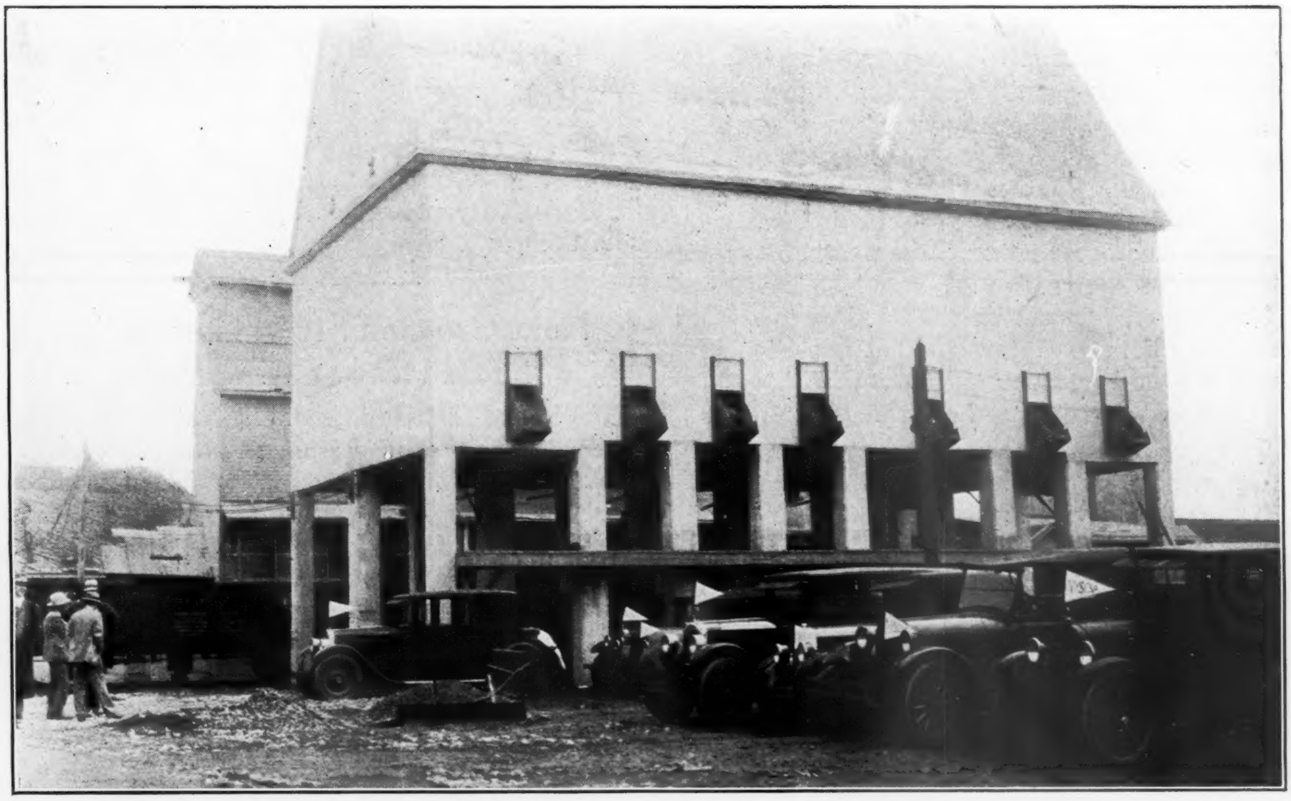
Conveyor From Primary Crusher Discharging to Second Conveyor That Elevates to Primary Screen

Locomotive Crane Used For Loading From Ground Storage, Car Shifting, etc.

at the end of the shafts. The whole drive runs in a bath of oil.

Eight sizes of stone are graded and they drop direct and straight down to their respective bins without hitting the sides. The storage bins have a capacity of 3,000 tons, are equipped both for truck and car loading. About 75 per cent of the business is handled by trucks. A fleet of 28 motor trucks, mostly Macks, with a few Whites, handle the truck delivery.

A Browning locomotive crane is used for shifting cars and miscellaneous work around the plant. An Ohio locomotive crane is used for loading in and out of ground storage. Fairbanks scales weigh



Bin Storage For 3,000 Tons of Graded Stone the trucks and stone is sold by weight. Rail shipments are made over the New York Central Railroad as the main line runs by the plant and through the property owned by the Dolomite Products Company. U. S. Rubber belts are used in the plant. The 185 foot belt runs over Brownhoist idlers. The two 90 foot belts run over Robins idlers.

The night operations of this company have been particularly successful. Fourteen men are used at night from shovel to top of bins. There is no shooting, drilling or delivery trucking at night. Two 1,000 watt lights play over the quarry. Two 250 watt lights are used in the shovels. Other lights are distributed around the plant as needed.

A cement products plant is also operated by the Dolomite Products Company. Considerable development is planned with this plant. Three men and hand methods are employed at present. Eventually this plant will handle chicken grit, turkey grit, agricultural limestone, stove polish and other products.

The officers of the Dolomite Products Company consist of John Odenbach, president, treasurer and general manager; Mathew P. Odenbach, vice-president, and Frank J. Waddell, secretary. Harvey N. Clark is superintendent in charge of the plant and J. M. Cassevoy is night superintendent.

The sixty odd guests at the plant were impressed. Some of the old timers in the crushed stone business were more impressed with the fact that John Odenbach had built a profitable business with a plant producing 2,500 tons per day from a start that included an unsuccessful plant producing only 200 tons per day and without any previous experience in the crushed stone business.

After this inspection the party started in automobiles to Manitou, a distance of 20 miles for an outing ad dinner. The stream of cars was decorated with banners and special flags announcing to all who came in contact with the procession that the New York Crushed Stone Association was holding its mid-summer meeting. The weather was bad so the outdoor sports planned were held indoors at the big pavilion. Indoor baseball and races created pleasure for both spectators and participants. The umpire for the ball game did more than his share with the usual decisions to keep things interesting.

About seventy sat down to dinner at seven o'clock, and the association was honored with the presence of Mrs. Savage, several highway officials and engineers, John Rick, Otho M. Graves and A. T. Goldbeck. After dinner several short talks were made by Otho M. Graves, John Rice, A. T. Goldbeck, H. E. Smith, Charles Waters, W. L. Sporburg, George Powell, Bob Holmes, Ed Miller, N. C. Rockwood and H. W. Munday. The highway engineers present were all friendly in their comments. Charles Waters endorsed the laboratory idea for the National Crushed Stone Association. George Powell commented on the cleanness of the crushed stone now being produced. Ed Miller suggested that frequent contacts be made between producers and engineers to promote harmony.

Among those in attendance were Messrs. Savage and Hooker, Buffalo Crushed Stone Co.; Diebold; Foote, Wickwire Spencer Steel Co.; Anderson, Hercules Powder Co.; Waters, District Engr.; Storm and Georger, State Highway Dept.; Boice and Caldwell, Genesee Stone Products Co.; Hawthorne and Rosenberg, General Crushed Stone Co.; Howe, Le Roy Lime & Crushed Stone Co.; Scott and Rancier, General Crushed Stone Co.; Helsden, Helsden & McClurg; Helwig; Holmes, County Highway Supt. of Wyoming Co.; Thomas, Wyoming Co. Highway Dept.; Nichol, Cross Engineering Co.; Conely, Union Explosives Co.; John Odenbach, Chas. Odenbach, Mathew Odenbach, Waddell, Sickles, Clark, Cassavoy, Daley and Harris, Dolomite Products Co.; Burns, Doyle Oil Co.; Schaefer and McCone, General Crushed Stone Co.; Wedd and Bannard, Erie Railroad Co.; Davis and Williams, B. R. & P. R. R. Co.; Rockwood, Rock Products; Munday, Pit & Quarry; Kurtz, Lehigh Valley R. R. Co.; Rice and Graves, General Crushed Stone Co.; Schmidt, Buffalo Crushed Stone Co.; Croll, General Crushed Stone Co.; Sporburg and Frank Owens, Rock Cut Stone Co.; Powell, Ontario Co. Supt. of Highways; Montagne, Ontario Co. Highway Dept.; A. L. Owens, Peerless Quarries; Gray, Peerless Quarries; Smith, Dist. Engr. State Highway Dept.; Larsen, Kelley and Gaffney, State Highway Dept.; Johnson, Adams & Duford Co.; Norton, DuPont Powder Co.; Hodgkin, Gouverneur Limestone Co.; Chambers, Highway Contractor; Barnes, Wayne Co. Supt. of Highways; Ripton, Ripton Stone Co.; Goldbeck, Washington, D. C.; Cheney, Marion Steam Shovel Co.; Miller, Asst. Comm. Public Works, City of Rochester; Van Gelder, Public Works, City of Rochester; Nelly, Dolomite Products Company.

Next Crushed Stone Convention To Be Held at West Baden

The Board of Directors of the National Crushed Stone Association in session at Atlantic City the week of July 25th selected West Baden Hotel at West Baden, Indiana, for the next annual convention to be held January 16th to the 19th inclusive.

West Baden is an internationally famous resort. It adjoins French Lick. In selecting West Baden the Directors of the National Crushed Stone Association have departed from the usual custom of holding the annual meetings in some city. Producers attending the convention will find it easy to attend the convention sessions as the only diversion from the hotel is the famous Brown Club.

MICA
SOURCES, PRODUCTION AND MARKETS

By W. M. Myers
Mineral Technologist, U. S. Bureau of Mines

Part I

THE growth of the electrical industries together with the constant expansion in the use of electrical equipment by the public has created an increasing interest in mica. Its unusual combination of physical properties, particularly its dielectric strength, highly developed cleavage, transparency and flexibility, together with the ease with which it may be manufactured into finished parts, has caused mica to be considered an indispensable component in certain types of electrical equipment. Attempts to find satisfactory substitutes have been rewarded with but limited success and it is expected that the commercial importance of mica will increase in the future in proportion to the growth of the industries in which electricity is of prime importance. The remarkable development of the radio industry in the last few years has been dependent in part on the availability of high-grade mica. This market has consumed large quantities of the smaller sized sheet material suitable for use in condensers.

In the preparation of this circular information has been obtained by visits to mines and through conferences with producers and dealers.

Varieties of Mica

The term "mica" is applied to a group of minerals which display great variation in chemical composition although many of their physical properties are similar. The most pronounced physical property which they possess in common is highly developed cleavage which permits the separation of mica aggregates into sheets with more or less facility depending upon the variety.

The varieties of mica and their theoretical composition are:

Variety	Theoretical Formula
Muscovite	$H_2KAl_3(SiO_4)_3$
Phlogopite	$H,K,(MgF)_3,Mg_3Al(SiO_4)_2$
Biotite	$H,K_2(Mg,Fe)_2(Al,Fe)_2(SiO_4)_3$
Lepidolite	$K,Li\ [Al(OH,F)_2]\ Al(SiO_3)_3$
Roscoelite	$H_8K(Mg,Fe)(Al,V)_4(SiO_3)_{12}$
Paragonite	$H_2NaAl_3(SiO_4)_3$
Zinnwaldite	$(K,Li)_3FeAl_3Si_5O_{16}(OH,F)_2$
Lepidomelane	Similar to biotite, rich in ferric iron

These theoretical formulas have not been established definitely and are of little value other than demonstrating that the micas are complex silicates of variable composition. The micas are commonly designated by the name of one of the characteristic elements. Muscovite is called "potash mica"; phlogopite, "magnesium mica"; biotite, "iron mica"; lepidolite, "lithium mica"; roscoelite, "vanadium mica"; and paragonite, "sodium mica."

The composition of specimens of mica as determined by chemical analysis varies greatly from the above formulas, due partly to inclusions of foreign minerals and to the replacement of equivalent elements. The following analyses represent some typical specimens:

	Muscovite India	Muscovite N. Carolina	Phlogopite Canada	Biotite Maine	Lepidolite Maine	Roscoelite Colorado
SiO_2	45.57	45.40	39.66	34.67	51.52	46.06
TiO_2	....	1.10	.56	....	....	....
Al_2O_3	36.72	33.66	17.00	30.09	25.96	22.55
Fe_2O_3	0.95	2.36	.27	2.42	.31	.73
FeO	1.28	....	.20	16.14	....	....
MgO	0.38	1.86	26.49	1.98	.02	.92
CaO	0.21	....	....	....	.16	.44
Na_2O	0.62	1.41	.60	1.67	1.06	.22
K_2O	8.81	8.33	9.97	7.55	11.01	8.84
Li_2O	0.19	....	....	....	4.90	....
H_2O	5.05	5.46	2.99	4.64	.95	6.05
F	0.15	0.69	2.24	.28	5.80	....
BaO	....	....	.62	....	....	1.35
MnO	....	....	....	.85	.20	....
V_2O_3	....	....	....	....	....	12.84
	99.93	100.27	100.60	100.29	101.89	100.00

Muscovite and phlogopite are the micas of commerce. The other varieties of mica either are not available in sufficient quantities or do not possess the proper characteristics to attain industrial importance. Phlogopite is mined in only two countries, Canada and Madagascar. Aside from brief reference to phlogopite the following description of the properties, production and utilization of mica applies only to the different types of muscovite which constitute practically all of the mica production of this country.

The other varieties of mica are discussed briefly in a few paragraphs at the end of this report.

Physical Properties

Mica possesses unique physical properties which are not equaled by any other known material, and account for its industrial importance. Mica crystallizes in the monoclinic system, commonly in pseudo-hexagonal shapes. Hardness varies from 2 to 2.5; specific gravity from 2.7 to 3.0; index of refraction from 1.56 to 1.59; lustre is pearly to vitreous, thin plates transparent to translucent, thick plates transparent to opaque; cleavage plates are flexible and elastic. Mica has a basal cleavage which is very highly developed, permitting the separation of masses into thin films with great precision. Mica from different sources varies in perfection of cleavage and ease of splitting. For use in some of the highest grades of electrical work thin films must be prepared with no variation in thickness; a perfect cleavage is therefore desirable. The color of mica is dependent upon the thickness of the piece examined. Thin films from deeply colored plates may be colorless. In general mica is colorless, or of a brownish-red, or greenish cast. Zonal coloration following the crystal structure is occasionally encountered. The hardness of mica varies with locality; the harder micas appear to be less flexible and therefore less desirable. The edge of a mica plate will generally display greater hardness than the face. Variations in dielectric strength or electrical resistance are common. In general these variations are due to the presence of impurities in the mica, the most common impurity consisting of oxides of iron which are very injurious in that their presence lowers the resistance of the mica by presenting spots of weakness through which high voltage currents may pass.

Occurrence of Mica

Muscovite mica of commercial size is found only in deposits of pegmatite, which are similar to granite in mineralogical composition but are characterized by coarse crystallization. The mica-bearing pigmatite is composed essentially of coarse grains of feldspar and quartz, accompanied by mica, the latter being present in masses known as "books" which vary greatly in size. Accessory minerals, such as garnet, tourmaline, agatite, topaz, beryl, cassiterite, tantalite and others, are commonly present in small quantities. Pegmatites vary in width from a few inches to 100 feet or more. They are irregular in form and appear as stocks, chimneys, lenses, sheets, and masses in rocks of granitic character. Branching and sudden contractions in widths are common. The largest mica is generally found where very coarse crystallization prevails. The mica books may be scattered through the pegmatite mass irregularly or may display a tendency to concentrate near the contacts with the surrounding rock.

Feldspar on weathering tends to decompose and form other minerals, particularly kaolin. Kaolinization is accelerated by moisture and warm temperatures, and therefore is most marked in feldspars of the southern states. Pegmatites are frequently kaolinized to considerable depths. This results in disintegration of the rock mass so that it may be readily excavated, which facilitates mining operations. Mica is apparently unattacked by the agencies that cause kaolinization, and is often found unchanged although the surrounding feldspars have been entirely altered.

Although muscovite mica is found principally in pegmatites, the occurrence of pegmatite formations does not necessarily imply the presence of marketable mica. This is illustrated most strikingly by the States of Maine and California, both of which contain many pegmatites which are important sources of feldspar but have not produced any appreciable amount of mica suitable for commercial use.

The value of sheet mica depends upon its freedom from stains and inclusions of impurities, and also upon the absence of folding and distortion due to movement of the enclosing rock. The degree of metamorphism to which the rock mass has been subjected during or subsequent to the crystallization of the mica is therefore an important factor. Where the agencies producing metamorphism, particularly great pressures and accompanying movement, have been in evidence the mica may have been so distorted as to be wavy, ruled, and with an imperfect cleavage so that even sheets can not be produced. Mica of this nature is worthless for the manufacture of sheet material and can only be used as scrap for the manufacture of ground mica. The best mica is found in regions of geologic stability. The largest and most important mica producing areas of the world are in such regions.

Mica occurs in many granites, gneisses and schists. In these rocks it is present in such small scales that it can not be recovered in marketable form; except that some mica schists are composed almost exclusively of mica and this material may be ground and used for the same purposes as ground mica manufactured from scrap.

Distribution of Mica Deposits

New Hampshire is now the leading producer of sheet mica in the country. In 1925 New Hampshire supplied 62 per cent of the total quantity of domestic sheet mica sold by producers in the United States. The mica-bearing belt extends from Surry, in Cheshire County, in a northeasterly direction to Easton, in Grafton County. Several mines are operated in the vicinity of Grafton. The Ruggles mine, operated by the Standard Feldspar Co., has been worked intermittently since 1803, and has produced a large quantity of high-grade sheet mica. The handling of mica is centered principally in the towns of Keene and Rumney Depot.

Until 1923 North Carolina was the most important mica producing State. It still is the largest producer of scrap mica. Its production of sheet material is exceeded only by New Hampshire. Most of the production comes from the western part of the State, particularly from Mitchel, Avery, Yancey, Buncombe, Haywood, Jackson, and Macon counties. Some mica is recovered as a by-product in the operation of feldspar mines located in the vicinity of Spruce Pine. Similarly some scrap mica is recovered in the operation of kaolin deposits. Many small deposits are operated irregularly by farmers during slack times. This production is sold to buyers who buy mine-run mica from many different sources for use in the manufacture of mica parts. The handling of mica is centered in Spruce Pine, Franklin and Asheville.

Mica is produced in small quantities in Alabama, Colorado, Connecticut, Georgia, Idaho, Maine, Nevada, New Mexico, South Carolina, South Dakota, Texas, and Virginia. At present this group of States produces approximately 5 per cent of the total sheet mica of the country. In the past some of these States have been important producers and it is possible that future developments will result in an increased production from some areas. The deposits in Alabama, Georgia and South Carolina are similar to those of North Carolina. Most of the mica production of South Dakota is scrap which comes as by-product in the operation of feldspar properties. A small production of sheet mica is obtained in the vicinity of Custer, a district which at one time was a well-known producer. A number of mines are operated in the Petaca district in northern New Mexico. Considerable activity in the development of mines in this district during the past year promises an increased production from this State. Considerable interest has been displayed recently in the mica deposits in Ruby Valley, Nevada, and in Culberson County, Texas.

Prospecting for Mica

When pegmatites do not outcrop at the surface their presence can not be detected readily. In the northern States, especially New England, large areas have been eroded by glaciation, leaving many pegmatite outcrops. These exposures have been located readily and in some instances have been developed into successful producers of mica and feldspar. In the mica-producing States in the southern unglaciated area, the presence of pegmatites may often be noted even where several feet of residual soil covers the rock surface. Much of this soil is clay derived from the kaolinization of the feldspars. The unaltered mica is found in this clay and on the surface, where its presence is a valuable guide to the identity of the underlying rock. The course of a pegmatite may be traced for considerable distances by the presence of mica in the soil. These surface indications are the principal means by which mica deposits are located. The occurrence and structure of pegmatites, together with the uncertainty of their mica content, is such that systematic prospecting is not justified. Few attempts have been made to locate prospects by a definitely planned course of tunneling or drilling. After the location of a promising looking pegmatite, ordinary procedure consists of driving a shaft or drift into the rock where the most mica is in evidence. If the mica proves to be of such poor quality that no sheet material could be produced, the prospect is immediately abandoned unless the mica is so abundant that mining for grinding scrap alone would be warranted. If mica is found which will produce some sheet material and the operation appears to be promising, mining is continued with the least possible financial investment until enough mica is recovered for sale to afford some idea of the returns in comparison with the costs.

Mining Methods

The irregular structure of pegmatites has had a marked effect on the development of mica mines, for it has tended to make large systematic operations impossible. The likelihood that as mining advances the pegmatite formation may suddenly decrease in size or that the mica will cease to be present in paying quantities increases the uncertainty of successful operation. The industry as a whole is characterized by numerous small operations, many of which are worked intermittently according to the price of mica or the leisure of the owner.

The simplest form of mining consists of "gophering" or simply digging from one mica book to the next as long as profitable. Mining is conducted with a minimum of equipment and expense and only the best grade of mica which may be easily reached is recovered. Much of the mica is not recovered, and after abandonment such workings are frequently left in such condition that future mining would be greatly hampered. Such operations are uneconomic but are continued because they permit the extraction of some mica at a profit, and also because such openings have served to prospect unknown ground with the result that occasionally deposits have been found which justify better equipment and more regular operation.

Some deposits are opened by a shaft, but more commonly where pegmatites outcrop on hillsides they are worked either by an open cut or by driving a tunnel adit. Natural drainage from such a working is an advantage. Some open-pit workings have been abandoned on account of water accumulating as soon as the excavation reached water level. In these small, irregular operations drilling is done by hand, the holes shot with black powder or dynamite and the broken rock removed in wheelbarrows if possible, or hoisted to the surface with a windlass if the mine was opened by a vertical shaft.

In some of these small mines, more systematic operation and the purchase of better mechanical equipment has been justified where prospecting has disclosed a large pegmatite formation containing enough mica of the proper quality. Drilling is done with mechanical drills supplied with compressed air by portable compressors. The most common practice is to follow the streak of mica in the pegmatite, removing only enough rock to permit the extraction of mica. In drilling, either by hand or with mechanical drills, care is taken not to penetrate the books of mica. Drilling through mica is difficult due to the resiliency of the mineral. The experienced miner soon recognizes the difference in conditions when the drill encounters mica. When this happens the hole may be abandoned and another started to avoid spoiling of valuable mica. Timbers are used where necessary to hold the walls or roof. Occasionally the mica appears to be concentrated on one wall or to be associated with quartz, which serves as a guide in mining. Working down the incline on an outcrop of pegmatite with an inclined shaft and irregular slopes is probably the most common type of underground mining. Some flat-lying formations have been worked by room and pillar, leaving pillars wide enough to provide support. Feldspar recovered as a by-product may be separated and marketed to grinding mills. The possibility that the mine may suddenly cease to be profitable necessitates a minimum financial investment and minimum of equipment which may be moved readily to another locality if necessary. The mica books are so irregular in distribution that some parts of wide pegmatites are much richer than others. Whenever possible mining of the lean rock is avoided.

A few well planned, systematic mines have been developed in North Carolina, Alabama and South Dakota at points where large pegmatites having a fairly uniform mica content of known quality have been discovered. A remarkably large proportion of workable mica-bearing pegmatites dip at angles varying from 35 to 60 degrees from the horizontal. Some of the best examples of well-planned mines are in deposits having such a structure. Ordinary practice is to sink a vertical shaft in the country rock on the hanging-wall side, or else an inclined shaft on the foot-wall side. In either case tunnels (drifts) are driven to the pegmatite and the mica-bearing rock is removed by breast or overhead stoping. Such operations have not been remarkably profitable due to the comparatively large invesment involved which the mica returns have not compensated.

There is undoubtedly considerable justification for the crudities that characterize mica mining. The irregularity of the pegmatite deposits, and the uncertainty of the presence of mica, increase the hazard of successful operation. When one pocket of mica is exhausted there is no way of determining the presence of another except by continued mining in waste ground. Diamond drilling may be of some assistance but is expensive and results are apt to be misleading. The value of a deposit depends not only upon the amount of mica present, but upon its quality, which can only be determined by examination and use. Thus, the miner is constantly confronted with uncertainty regarding both supply and quality.

The feldspar production of the country is obtained from similar pegmatites, and in many of the feldspar-mining operations some mica is derived as a by-product. Many of the feldspar mines or quarries have been developed on a fair-sized scale, owing to the necessity of producing a large tonnage in order to justify operation. These feldspar deposits with few exceptions are worked as open-cut quarries. They are supplied with air compressors, mechanical drills, and mechanical haulage for the removal of the ore. The rock is stripped, if necessary, to remove overburden, drilled with jackhammers, and shot with the proper explosive, generally 40 per cent dynamite. The broken ore is cobbed by hand, the clean spar being thrown into quarry cars for removal to storage bin. The mica encountered is generally thrown to one side; later it is sorted into clear flat material suitable for trimming into sheets and scrap which is set aside for storage and grinding. The production of by-product mica in feldspar mining often provides an additional source of income which may pay a large part of the cost of operation of the property.

Preparation of Mica for Market

Mine-run mica consists of broken crystals or books which vary greatly in dimensions. This material, after removal from the mines, is cleaned from any adhering dirt or other minerals and is then taken to the trimming shops, where it is prepared for market. Flat, unstained and undistorted mica is most valuable. Much of the mine-run material contains imperfections which must be removed.

Disturbed crystallization is a prolific source of imperfections in mica. "Tangle-sheet" or "tanglefoot" mica is one which splits with difficulty and commonly with tearing of the sheets. A "ruled" mica is one that has planes of separation other than the regular cleavage planes. Various terms are applied to ruled mica, such as "ribbon," "wedge," "spear-head," "A," "hair-lined," "reeved," "fishbone," "herringbone" and "horsetail." "Cross-grained" is a term applied to a mica which breaks transversely when split. Such breakage may be due to the presence of partings or gliding planes probably induced by pressure. They are developed at angles of about 66½ degrees to the cleavage plane. If a series of such planes occur in parallel arrangement they may divide the mica into long narrow strips of little value.

"Wedge" mica is a term applied to blocks thicker at one side than at the other. Such variation in thickness is due to unequal width of the laminae, some of which extend entirely across the block and others only part way across. Films of nonuniform thickness may result from splitting wedge mica. Mica sometimes shows a pitted surface but this probably has no relation to the original condition of the crystals; it may be caused by solution.

Mica may also be wavy, buckled, or corrugated, conditions which probably result from earth movement at the time of, or subsequent to, crystallization. Defects may be due to intergrowths of crystals, either of the same or of different micas. Intergrowths of biotite and muscovite are common. Mica sheets in which any of the above imperfections are pronounced are useful only for scrap.

"Spotted" or "specked" mica contains extremely thin scales or streaks of dark minerals, chiefly the iron oxides, which lie between the laminae but do not penetrate the sheets. The inclusions in some crystals are arranged in lines corresponding with certain crystallographic directions of the mica, and thus form many interesting and peculiar patterns.

The inclusions may be so abundant that the mica mass is opaque. Black stains usually consist of magnetite. By decomposition the magnetite may be altered to hematite or limonite, and may thus give red, yellow or brown stains. Thin scales of iron oxide which lie between the laminae without penetrating the sheet do not greatly affect the insulating power of the mica for low-voltage uses.

Clay-stained mica is that which has clay or other form of soil impurity between the laminae. The clay may lie only in certain planes and may thus be split off and removed. Clay-stained mica is usually confined to the upper parts of deposits in the zone of weathering. For colored mica, rum, ruby, or green shades are the colors most in demand. A dark color detracts from transparency and thus lowers the value of mica for purposes where light transmission is desired. Zonal variations in coloring may appear to be imperfections, but when such mica is split into thin films the color effects usually entirely disappear.

Mica Trimming and Cutting

Sorting, cleaning, grading, trimming and cutting of mica are essentially hand processes, and little progress has been made in developing mechanical methods. Although several machines have been patented, and various mechanical processes have been tried, it is probable that such work will be conducted by hand methods for an indefinite period. The producing localities that have abundant cheap labor have a definite advantage therefore over regions where labor is high and scarce.

The masses of mica as taken from the mine may be roughly hexagonal in shape, but are more commonly in the form of irregular masses. These blocks are termed "mine-run," "run-of-mine," "book mica," or "block mica." The latter term is unfortunate as it is also applied to imported sheet mica. The mica is first "cobbed," that is, all adhering rock is broken from the mine-run masses. Ruled, wrinkled or otherwise defective blocks are discarded as scrap. The blocks are rapped with hammers to separate adhering dirt. Rough mica is commonly passed over a ½-inch screen to remove dirt and small fragments. The small pieces are later utilized as scrap.

Trimming sheds are provided at some mines, but most of the small miners sell their rough-cobbed mica to firms who sort, trim, and manufacture into forms desired by electrical companies and other consumers.

Cobbed mica of good quality is split into sheets ⅛ inch thick or less. Workmen who perform this operation are known locally as "rifters." Where imperfections are present at intervals between the laminae, skill and judgment are required to so split the blocks that the imperfections may be removed. The increased percentage of high-grade mica that may be obtained by proper splitting certainly justifies the employment of skilled rifters. In handling amber mica, the masses, which may be several inches thick, are first split into plates about ¼ inch thick. The edges of these plates are then hammered to loosen the laminae, so that the splitting-knife may be easily inserted. A double-edged 3-inch blade with a V point is used. The sheets are split to about 1/16 inch, and all edge imperfections are cut away.

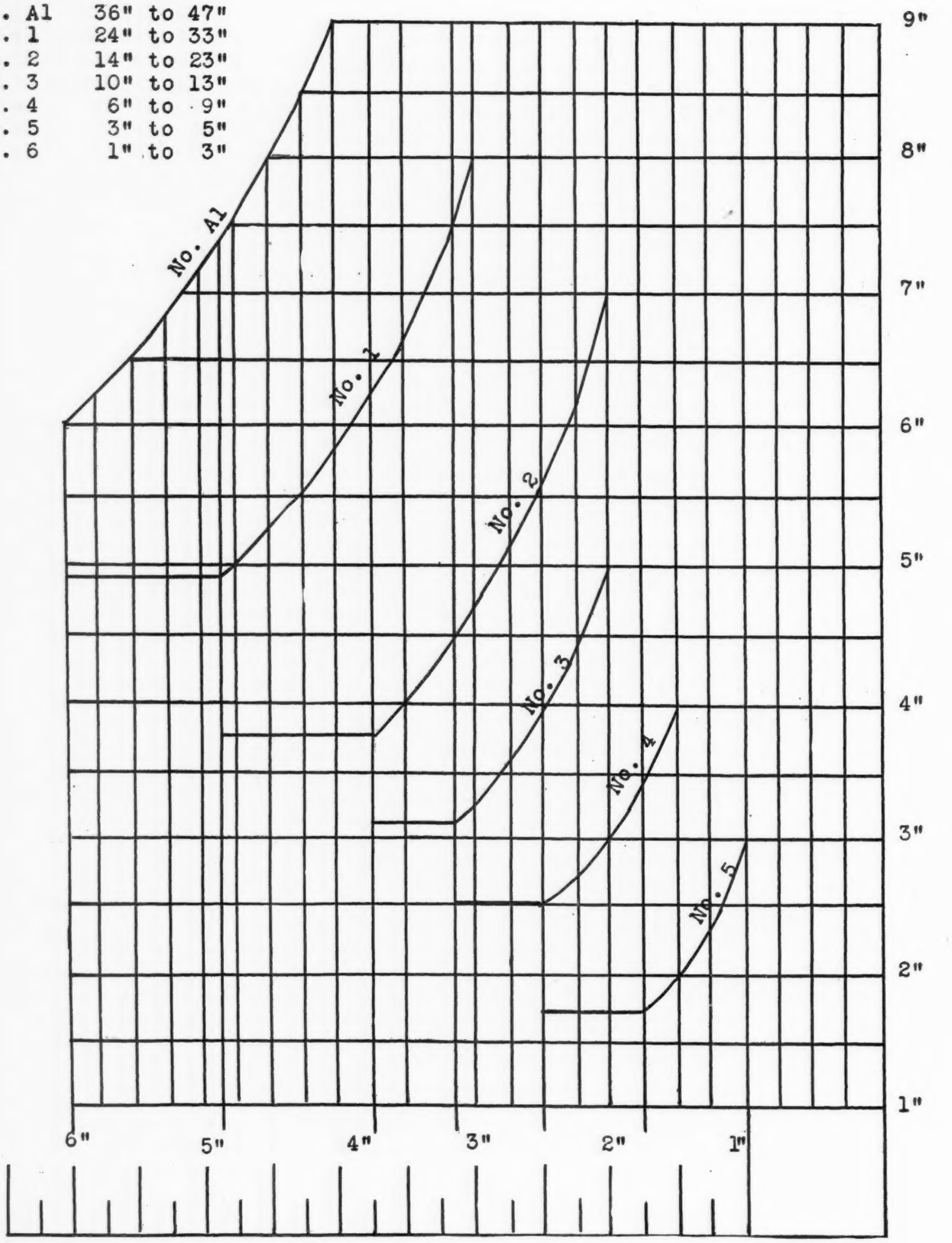
After rifting the sheets may be "thumb-trimmed" by breaking off with the fingers all inferior material around the edges, or they may be "knife-trimmed." The removal of the zone of etched, crushed or tangled mica from the outer edges greatly facilitates further splitting. "Sickle-trimmed" or "Indian trimmed" imported mica is closely knife-trimmed, practically all flaws and cracks being removed. In this respect it differs from domestic knife-trimmed, much of which is marred by cracks and flaws. The sickle-trimmed sheets are irregular rounded rectangles, cut with beveled edges. "Madras-trimmed" mica is that obtained from Madras, India. It is cut into approximately square patterns, and is known as "shear-trimmed," for it is cut with shears, and the edges are not bevelled, but are cut normal to the cleavage plane. Trimmed mica is known as "uncut" or "unmanufactured." It is graded according to size and quality. It may be sold to the consumer in uncut form, or it may be cut into any desired final size or shape.

Manufacture of Sheet Mica

Uncut mica is split into thin films and cut into various rectangles, circles or more complex forms. The smaller masses are split as described on a later page, or are manufactured into discs, washers and various small forms. Washers and related forms are made with power machines fitted with compound dies, cutting outside and center hole at one operation. Washers vary in size from ⅝ inch to 2 inches in diameter, and the center holes from ¼ inch to 1 inch. Washers may be built up with shellac to any thickness desired. Aside from the die machines practically all trimming is done by hand, though an electrically operated rotary trimmer has been used in Canada.

Most of the trimming and cutting, including the operation of die machines, is done by girls. The tools employed in mica trimming and splitting are very simple in character, consisting of hammers, splitting knives, scissors, and heavy hinged knives like paper cutters. A thin-bladed hardwood knife is sometimes used, for wood is less liable than metal to scratch the soft surface of the mica. A rasp may be fastened to the bench in a convenient position to rub the edge of the block of mica so as to open up the sheets for splitting. Trimmers are provided with a set of wooden, metal or composition blocks or templets of the various standard

Size Grades	Squares Inches
No. A1	36" to 47"
No. 1	24" to 33"
No. 2	14" to 23"
No. 3	10" to 13"
No. 4	6" to 9"
No. 5	3" to 5"
No. 6	1" to 3"



Classification of Mica according to the "India" Scale of Grading. The blocks of mica to be graded are placed at the lower right hand corner with the longer diameter running vertically. The position of the upper left hand corner of the block determines its grade and the curves on the chart indicate the minimum size of each grade. The range of areas of each grade is shown in the upper left hand corner.

shapes and sizes. Cutters become skilled in judging instantly the maximum standard size that any given sheet will provide. The proper templet is placed on the sheet, and the latter is trimmed to size with the scissors. The hinged blade is used chiefly to trim the larger sheets of stove mica. The finished sheets are carefully sorted according to size and quality, and placed in packages, containing a specified number or weight. They may be rectangular, circular, curved or may be of more complex design. It is imperative that the sheets in a package be uniform in quality and color. Canadian records show that each trimmer of amber mica produces 40 to 45 pounds of medium-sized sheet mica per day.

Many standard shapes and sizes of sheet mica may be kept in stock, but no manufacturer who is unfamiliar with the requirements of the trade, and the relative demand for various sizes and shapes, should attempt to cut mica to final form. Some companies have been almost, if not bankrupted, by stocking up with unpopular sizes which would not sell. Unless thoroughly familiar with the consumer's requirements a manufacturer should either sell his mica in uncut form or should cut only on contract.

Considerable improvement is possible in the trimming and grading of mica, and such improvements would assist greatly in popularizing domestic mica. Mica users prefer India mica in many instances not because of superior quality, but because it is so carefully graded and trimmed that little waste results from manufacturing processes. Much of the domestic mica is not so closely trimmed or carefully graded; therefore, a much higher percentage of loss results, and the consumer is prejudiced against the American product. There is a very high percentage of waste in the trimming and cutting processes. Usually 90 per cent or more of the original block is cut away and can be used only as scrap for grinding. The small proportion of finished sheet mica obtainable renders many mica enterprises unprofitable. A careful inquiry by the United States Geological Survey indicated that for the years 1916 to 1918, block mica as obtained from a number of important mines yielded only 9 per cent uncut sheet, and 26 per cent uncut punch. The final yield of cut mica was 3 per cent sheet, and 8 per cent washers, while the remaining 89 per cent was scrap.

Manufacture of Mica Splittings

The manufacture of "splittings" to be used in "built-up" mica is a very important branch of the industry. Those made in Canada from amber mica are known as "thin-split mica." In the United States the terms "splittings," "skimmings" and "films" are also applied.

Splittings are very thin films of mica obtained from pieces too small for use as sheet material, or from the smaller sizes of sheet goods where a better quality product is desired. They are one-thousandth of an inch or less in thickness, and of one square inch or larger in area. The films must have no thick edges or corners and must be free from all inclusions of other minerals. Practically all muscovite mica splittings are prepared in India, a country well supplied with mica and cheap labor. Phlogopite mica splittings are manufactured in Canada and Madagascar. In the United States high labor costs have prohibited the preparation of this material in commercial quantities. In India much of the splitting is done by children who possess a delicacy of touch which is an aid in the production of such thin films. Two classes of splittings are produced. Loose splittings are made from small irregular pieces of mica and are small and characterized by irregular outlines. Pan-packed splittings are made from small sheet goods, generally sizes No. 4, 5, and 6. This material, having been prepared from trimmed sheets, has even outlines and greater area. These splittings are packed in pans so as to produce a laminated coherent mass. The price of pan-packed splittings is necessarily much greater than that of loose splittings.

Grades and Specifications

As regards quality, mica is classified in three grades, clear, slightly spotted and stained, and heavily spotted and stained. While this basis of classification is not objectionable the absence of definite limits for each grade causes much confusion. Spotted mica is sometimes sold as clear and this has resulted in prejudice against the domestic product. As regards classification by size, the United States, Canadian and Indian systems are all different. In general the United States and Canada micas are classed on the basis of rectangular dimensions of pieces that may be cut from the sheets, while the India classes are on the basis of area in square inches of the rectangles that may be obtained.

The United States classification is as follows: The lowest grade of sheet mica is designated as "punch." The uncut sheet must be of sufficient size to yield a circle 1½ inches in diameter if stained and 1¼ inches if clear. The next size "circle" should provide a disk nearly 2 inches in diameter. The smallest rectangle is 1½x2 inches and the sizes following are 2x2; 2x3; 3x3; 3x4; 3x5; 4x6; 6x6; 6x8; 8x10 and larger. When properly trimmed the uncut mica sheet is approximately 1½ times as large as the maximum standard rectangle that may be cut from it. Each class includes the size designated and all larger sizes until the next class is reached. Thus a sheet that would cut to a rectangle 3½x5½ inches or 3½x6 inches would be classed as 3x5.

Canadian phlogopite is also classed on the basis of dimensions of rectangles obtainable, but the sizes differ somewhat from the United States standards. They are as follows; 1x1; 1x2; 1x3; 2x3; 2x4; 3x5; 4x6; and 6x8. The Indian classification is based on the area of usable mica in the sheet, for which 10 arbitrary classes have been provided. Of course some limitation must be placed on dimensions, for long narrow strips, though having large areas, would be suitable for few purposes. The accompanying chart is used to classify mica according to the India grades. The blocks of mica to be graded are placed at the lower right hand corner of the chart with the longer diameter running vertically. The position of the upper left-hand corner of the block determines its grade. The curves indicate the minimum size of each grade. Thus if the corner of the block is located to the left of curve 3 but does not reach curve 2, the mica is in No. 3 grade. The approximate range in area of the various grades in square inches is shown in the upper left hand corner of the chart. The three sizes too large to be shown in the sheet are designated "special," having a range of area 48 to 59⅞ inches; "extra special," 60 to 71⅞ inches, and "extra extra special" having an area of 72 square inches or over.

Requirements of mica for electrical purposes relate to dielectric strength, heat resistance and flexibility. All good electrical mica is sufficiently resistant to heat for ordinary electrical equipment and this quality is therefore rarely specified. Specifications for dielectric strength vary for different uses and with different consumers for similar uses. Mica has such a high dielectric strength that failures must commonly occur in defective spots. Therefore, in selecting material where high dielectric strength is required, it is very important that the mica be carefully examined and all defective sheets rejected.

Flexibility is an important property in mica that must be wound as in spark-plug manufacture or lamp chimneys. It is commonly specified that mica for spark-plug use must be sufficiently flexible that a sheet one-thousandth of an inch thick may be bent into a cylinder one-fourth of an inch in diameter without cracking or a sheet one-hundredth of an inch thick should bend to form a 3-inch cylinder without cracking. For stove use, or for similar purposes where transparency is required, mica is specified as "clear" and "spotted." There is great need of more rigid and clearly defined specifications for this property, as at present much mica sold as "clear" is decidedly spotted.

Many specifications for sheet mica call for India mica. This is due partly to the high quality of India mica which establishes it as a standard, and partly to prejudice against domestic mica due to improper grading and trimming. A rigid specification which rules out all but India mica certainly discourages development of the domestic industry, and domestic producers should endeavor to have specifications modified to read "India mica or its equivalent." This would give the domestic producer a fair opportunity to market a product of equal quality with the imported mica, and would encourage better grading and standardization of domestic mica.

Continuity of Operation

By R. M. Hudson

Does steady employment sustain consumption, or does steady consumption sustain employment? This query is much like the classic one as to which comes first—the hen or the egg? The answer seems to be that without the one we can not have the other. It is commonly understood that times are good when there are plenty of jobs for all who want to work, for then wages are usually good, and labor has money to spend for goods and commodities over and above the necessities of life. At such times, merchants are doing good business, and placing orders regularly with the manufacturers, thus assuring the employees of the latter steady work at good wages.

Census figures show we now have over 42,000,000 workers gainfully employed. Obviously we have the problem of maintaining conditions that will permit their full employment. In studying that problem we may well begin with a study of the degree of continuity of operation of the individual plants. What breaks the continuity? What causes shut-downs and lay-offs? Are these causes avoidable or controllable? What can be done to overcome them—or to safeguard against them?

"Lack of orders" may mean faulty sales planning or management. Perhaps the price is too high, because production and selling costs are unnecessarily high. In such cases, simplification often permits a reduction of cost that affords a lower price to the public, and buying is thus stimulated. Price reduction is often a splendid cure for "lack of orders." In his study of the "Regularization of Employment," Professor H. Feldman of Dartmouth says: "Perfect your sales program first, analyze your markets, simplify lines, etc." Through these methods, much can be done to bring in that volume of business which means continuous operation of the plant, and therefore steady employment for its workers, with consequent regular earnings and sustained or constant purchasing power. If every manufacturer sought diligently to overcome the conditions that interfere with or prevent his plant running regularly and continuously the year round, the bogey of unemployment, and consequent diminished purchasing power as evidenced in "lack of orders," etc., would vanish.

NEW EASTERN SAND AND GRAVEL PLANT PRODUCES BALLAST ECONOMICALLY

By F. A. Westbrook

THE Maine Sand and Gravel Company of Portland, Maine, has a new operation at Milton, New Hampshire, which supplies the entire Boston & Maine Railroad system with mixed gravel for road ballast and with sand for the locomotives. It also sells material for state highway and other construction work for delivery to points anywhere on the Boston & Maine system, but when other railroads become involved the freight rates become too high. At the present time most of the output is taken by the railroad. All shipments are made by railroad.

This plant, which was designed by the Link-Belt Company, has been in operation for less than a year, an additional crusher having been installed during June of this year. The property consists of about 60 acres which require very little stripping but the deposit contains a good many rather large cobbles or small boulders.

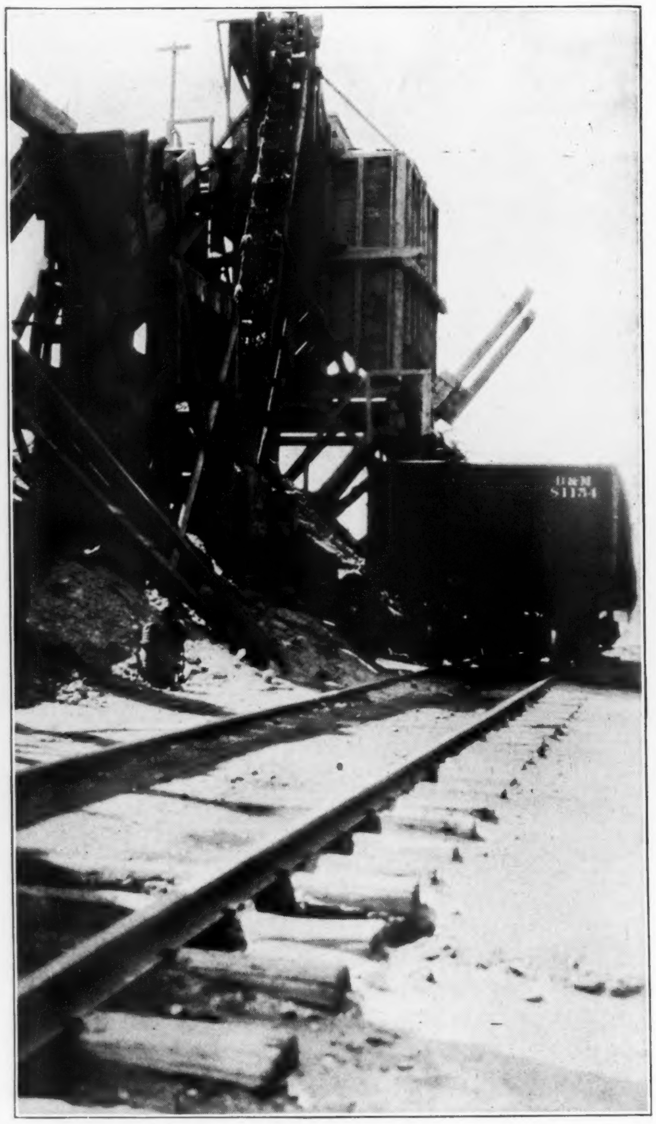
The deposit is worked by means of two steam shovels. One of them is a Type B Erie caterpillar with a 3/4 yard dipper and the other a traction type Thew, also with a 3/4 yard dipper. These shovels load the material in Western Wheeled Scraper Company 4 yard side dump cars which are hauled two at a time to the first grizzly by a Vulcan steam locomotive.

This grizzly consists of steel rails set 10 inches apart and on a slant. Material which passes through is of a size which can be handled by the machinery at the plant. It drops into a hopper from which it is drawn off into a 2 yard Western Wheeled Scraper Company side dump car and pulled up the incline by a Maine Electric Hoist Company hoist equipped with a 37½ h.p. General Electric Company induction motor. The wire rope was supplied by the American Steel & Wire Company.

The large cobbles which do not pass this first grizzly slip down the rails into the new number 20 Champion jaw crusher 24x52 in size.

When the stone has passed through this crusher it is picked up by a Link-Belt elevator, on 20 foot centers, and discharged by it into the bin under the grizzly, when it is taken up the incline to the plant with the other material, as already described. The installation of this additional large crusher greatly increases the capacity and efficiency of the plant—in the first place because it lessens the size of the stone to be crushed by the original primary crusher, and in the second place because it was found after operations got under way that there were so many large cobbles which would have to be discarded because they were too big to crush with the existing machinery that the efficiency of the operation as a whole would be adversely affected. Thus the new crusher is of double service in a way

View of the Plant as a whole. Note trough in foreground which carries off water from sand settling tank.



Upper Left—Close view of new crusher and train of cars from pit approaching the dumping place. Upper right—Elevator to sand bin and car about to be loaded from it. Lower—Locomotive and shovel at operation in the pit. Note large stones which the new crusher has been installed to break up.

which is not apparent at first sight.

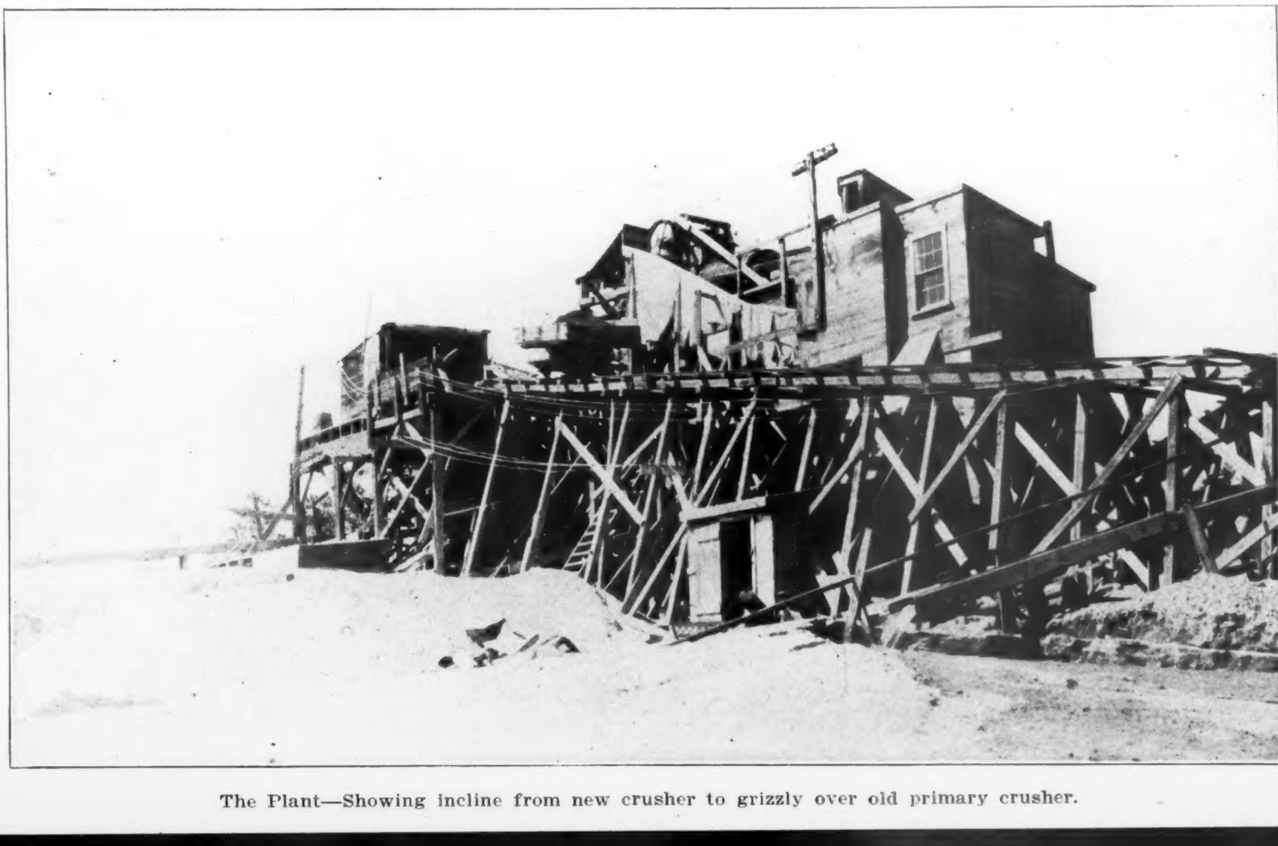
At the top of the incline the mixture of sand, gravel and crushed stone is dumped from the car over a grizzly designed to take out approximately all sizes over 2½ inches. The material which passes through the grizzly drops into a hopper and is fed by a Link-Belt reciprocating feeder to an elevator of the same make on 40 foot centers and having 24 inch buckets. It is an interesting fact that this elevator has not been out of service for any reason since it was installed. It discharges into a Good Roads Machinery Company roller-supported type cylindrical screen 4 feet by 16 inches in size. This is where the washing takes place.

The contract for the railroad ballast calls for a mixture of sizes between ¼ and 2½ inches so that all sections of the screen, when work is being done on that contract, have 2½ inch openings, an outside jacket being provided to take off the sand. The railroad mixture, or whatever commercial sizes are being produced, drop into the bins. Sand and water from the screen pass through a chute into a settling tank in the bottom of which is a Link-Belt screw conveyor. This screw conveyor pushes the sand into a chute which discharges into an elevator, made up of Link-Belt chains and buckets purchased from Hendricks, and drops it into other bins.

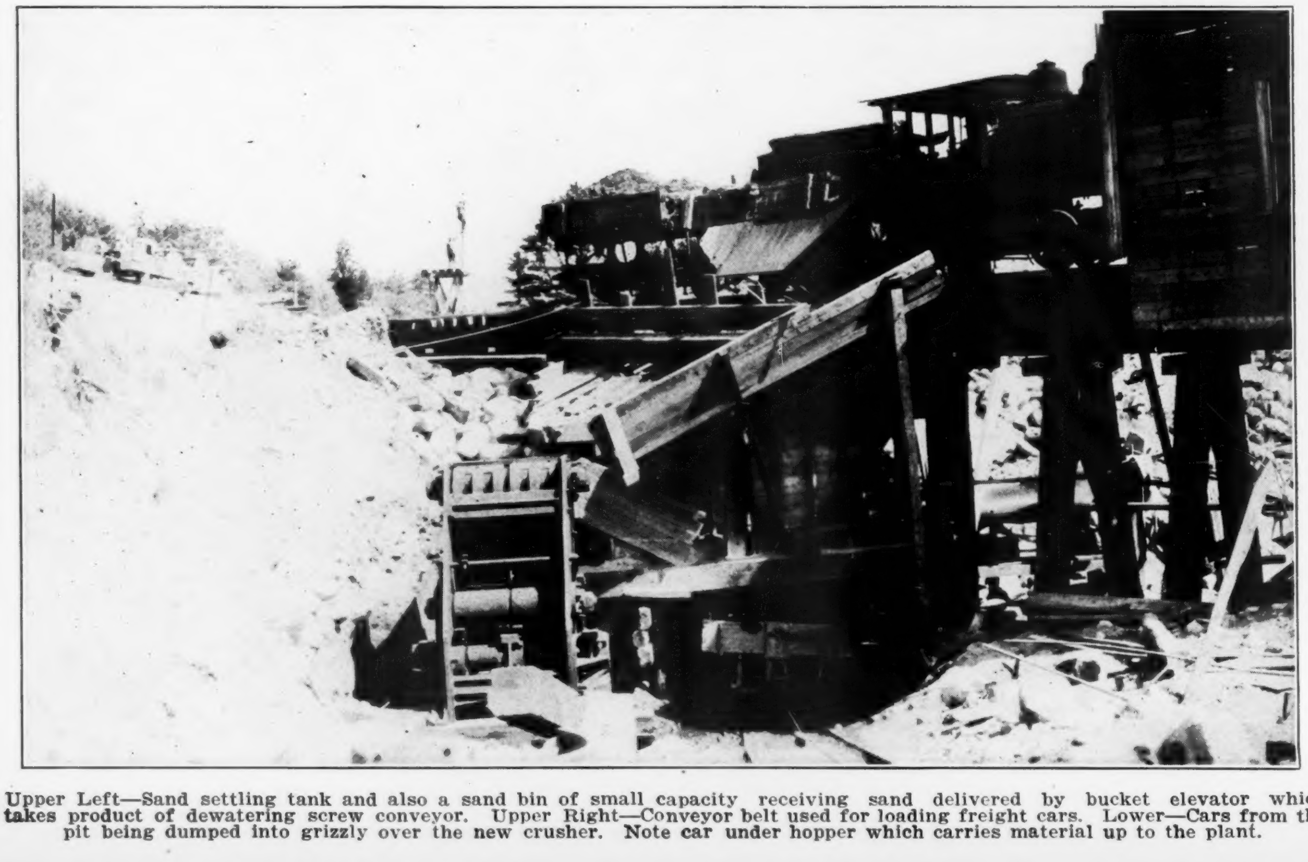
Now let us return to the grizzly at the top of the incline. Stones which are too large to pass this slip off into a number 7½ Kennedy gyratory crusher and this discharges into the main elevator leading to the cylindrical screen.

Of course there is some accumulation of oversizes in the cylindrical, partly from the number 7½ crusher and partly getting through the grizzly. These drop into a number 37 Kennedy gyratory

New elevator in foreground for loading freight cars. In the backbround is the belt conveyor and chute by which cars have been loaded in the past.



The Plant—Showing incline from new crusher to grizzly over old primary crusher.



Upper Left—Sand settling tank and also a sand bin of small capacity receiving sand delivered by bucket elevator which takes product of dewatering screw conveyor. Upper Right—Conveyor belt used for loading freight cars. Lower—Cars from the pit being dumped into grizzly over the new crusher. Note car under hopper which carries material up to the plant.

View of Steam Shovel, showing also Character of Gravel Bank

crusher. From this crusher the stone is taken on a 24 inch belt conveyor consisting of a Victor Balata belt and Stephens-Adamson idlers to the main elevator leading to the cylindrical screen.

The method of loading freight cars is entirely mechanical and for that reason interesting. Formerly a 24 inch Goodyear belt on Stephens-Adamson idlers was run on the outside of the storage bins, which were discharged into it through chutes. This conveyor carried the material up an incline to a loading chute equipped for giving the gravel a final washing before dropping it into the cars. This equipment is kept, but has been relegated to the position of an auxiliary. Now there is a Link-Belt elevator with 15 inch buckets for loading the cars. Chutes from the various bins are arranged to feed into a hopper at the base of this elevator and, as before, the gravel is given a final washing just before dropping into the freight cars. This provides for more convenient and more speedy loading, which is of importance when it is considered that as much as eighteen cars are shipped per day—usually in about the proportion of two cars of gravel to one of sand. Production averages about 900 tons per day of nine hours.

The loading siding, directly alongside of the main line of the railroad, is on a slight grade so that a limited number of cars may be shifted for loading without the aid of a locomotive. The railroad, however, provides a locomotive twice a day for shifting, necessary because the siding accommodates only twelve cars each side of the loading point.

The water supply for washing gravel is not a difficult matter at this plant. It is pumped 1100 feet from a nearby pond by means of a 5 inch Worthington rotary pump. After the water has been used it is allowed to overflow into an old part of the pit where it settles and then runs through a culvert back to the pond. There is never any shortage.

This plant, similar to the other operated by this company at Richland Street, South, Portland, Maine, is exceedingly neat and well kept up. It gives the same impression of well-being and prosperity as a well groomed person. A Fordson-Crescent (Crescent drag line) plays an important part in this detail of maintenance by being used to clean out the pit and settling pond. It is also used to make up stock piles of sand and gravel, although as a matter of fact there is rarely, if ever, much of any accumulation of the latter.

All machinery is electrically operated. Ten General Electric Company induction motors varying from 7½ to 100 h.p. in size are in service and a General Electric automatic circuit breaker has been installed which, by quick operation when trouble occurs in the plant, saves many fuses at the motors.

Proposed Argentine Highways Law

The project of September, 1925, for a national Argentine law to build a considerable system of highways throughout the Republic, will be discussed by the present session of Congress. The President submitted a message to Congress on June 14, reiterating the public demand that the projected law be acted upon without further delay. The message is timed with the statement of the chairman of the congressional committee on communication and transport that the committee will very soon submit its report on the project.

ROCK DUSTING COAL MINES SAVES LIVES BUT MUST BE THOROUGH

THE practice of rock dusting bituminous coal mines, as a means of preventing and limiting disastrous coal-dust explosions, has undoubtedly saved the lives of hundreds of American coal miners within the past two years, although the practice is not generally compulsory and is, therefore, by no means universally followed in the United States, Director Scott Turner, of the United States Bureau of Mines, Department of Commerce, points out. The partial rock-dusting of mines, or rock dusting by improper or inadequate methods, however, provides no assurance of safety, and rock-dusting may be worse than useless if it is not done adequately and systematically, Mr. Turner declares. Merely perfunctory scattering of rock-dust or sporadic rock-dusting at long intervals, or the rock-dusting of only a few main haulage ways, may result in an unwarranted sense of security. To provide adequate assurance against deadly mine explosions, all accessible open areas should be thoroughly rock-dusted, including haulage entries, air courses, rooms, cross cuts and pillar regions; and the rock-dusting should be replenished from time to time so as to hold the incombustible content of the rib, roof and floor dusts at all times over 65 per cent.

The unfortunate occurrence of several disastrous explosions in bituminous coal mines in this country within the past few months makes it an opportune time to review just what the practice of rock-dusting has accomplished toward preventing such explosions, Mr. Turner continued. It is now approximately two years since the rock dusting method has been tried more or less extensively in a considerable number of coal mines of the United States.

For the past ten years, rock-dusting has been required in the gassy and dusty coal mines in France; and no explosion disasters have occurred in the French mines during this period. In Great Britain rock-dusting has been required by law since January 1, 1921, in all but naturally wet mines, and since 1924 it has been required in all coal mines except the anthracite mines. Although many localized minor explosions of gas have occurred in face workings, no major explosions have occurred in rock dusted mines in Great Britain since January 1, 1921, except in the case of a recent explosion in South Wales, in which a strong gas explosion destroyed the ventilating currents. The government inspector reported that, had it not been for rock-dusting the disaster would have been more terrible.

In the bituminous mines of the United States from January 1, 1926, to May 1, 1927, there were 16 major explosion disasters, in each of which more than five men were killed. Two other incipient explosions in rock dust mines killed four men and one man, respectively. In all these explosions, 438 men were killed. Eight of the mines were rock-dusted, at least in the vicinity of the origin of the explosions of gas or coal-dust; and this rock-dust, by extinguishing the flames, localized, or aided in localizing, the explosions. Fifty-seven were killed by these incipient explosions, but 1,892 other men who were exposed to the liability of death escaped. According to the testimony of State mine inspectors, of mine operators, and of Bureau of Mines investigators, it is probable that a large proportion of these men would have been killed had it not been for rock dusting.

Two other explosions, occurring in partly or imperfectly rock-dusted mines, killed 131 men out of 173 who were in the mine. If rock-dusting is not efficiently done and maintained up to an approved standard, in parallel air passages as well as haulageways, it is not effective.

During this same period, January 1, 1926, to May 1, 1927, eight explosions occurred in non-rock-dusted mines, killing 244 men out of 761 in the mines. It seems clear that, from an explosion-risk standpoint, partly or imperfectly rock-dusted mines class with non-rock-dusted mines. On this basis, there have been, since January 1, 1926, ten major explosions in partly rock dusted and non-rock-dusted mines in contrast with seven explosions of a limited character in rock dusted mines. In the former, 555 men out of 934, or 60 per cent of the men in the mines, escaped, whereas in the rock dusted mines, 2,078 out of 2,135, or 97 per cent of the men in the mines at the time of the explosion, escaped death.

These figures clearly show the merit of rock-dusting. The method will not prevent local gas explosions, but if properly done and maintained, according to Bureau of Mines standards, there can be no doubt of its success in preventing great wide-sweeping coal-dust explosions that destroy numerous lives and a vast amount of property. The cost of rock dusting is comparable with accident insurance premiums, apart from the humanitarian and psychologic value in saving life and improving morale in coal mining.

All entries, rooms, and pillar or other open, accessible workings, should be rock-dusted at all points. The mine dust should be systematically sampled, the non-combustible content determined, and the results recorded by sections or zones. Redusting in any zone should be done when the non-combustible content falls to 55 per cent, to the end that the average content of the mine dust is held in excess of 65 per cent non-combustible.

SPEED OF SOLUTION OR SLAKING AND BURNING TEMPERATURE OF LIME

By P. P. Budnikoff

THE article which follows and which has been translated from a leading German magazine in the cement, lime, and stone industry contains the results of certain experiments which were made in the laboratories of the Technological Institute in Charkow, Russia. The article originally appeared in the Russian and was then translated into the German. It is not often that the work of Russian investigators comes to the attention of American cement men, but when they do, they are generally worthy of special attention, for the reason that the Russian chemists and engineers who do research work and publish the results of their work are invariably of high caliber and are well worth while studying.—Editor.

When lime is made, calcium carbonate, as is known, is dissociated at a high temperature in accordance with the formula: $CaCO_3{=}CaO{+}CO_2$. This is an endothermic reaction and in accordance with the experiments made by Thomsen (see Thermochemische Untersuchungen, page 444), 42.5 calories of heat are required for the decomposition of one molecule of calcium carbonate.

The pressure of the carbon dioxide gas attains one atmosphere at a temperatore of 900 degrees C. (See Johnsen, Journal of the Chemical Society, volume 33, pages 938ff, year 1918 and Riesenfeld, Journale de Chimie physique, volume 7, pages 561ff, year 1908). The rapidity of the decomposition of calcium carbonate increases with the temperature. When this process is carried out in practice consideration must be paid to the economy of the process, the chemical composition of the calcium carbonate and finally to the fire-resisting properties of the material which is employed in constructing the kiln. It is therefore understandable that it is not advisable to exceed a certain maximum temperature in the operations.

The burning of lime commonly takes place at a temperature which varies between 950 and 1000 degrees C. When the limestone contains but little impurities or admixtures, then the increase of the burning temperature above these points has practically no influence on the rapidity of solution or slaking. On the other hand when the raw material contains foreign substances, such as alumina, silica and iron oxide, then it cakes together at the high temperatures, which means that it forms a glassy-like surface layer, with the result that a "dead burnt" or over-burnt lime is obtained which is inactive as far as water is concerned. It will not slake at all or only very slowly. The presence of silica in the limestone has a very marked effect in tending towards the production of an overburnt lime. (J. T. Robson and J. R. Withrow, Journal of the Ceramic Society, volume 7, pages 74ff, year 1924.) According to Herpfeld a proportion of twenty-seven per cent of silica in the limestone acts in such a manner that the latter substance yields a "dead-burnt" product if it is burnt for a period of two hours. Herpfeld has also determined that a pure limestone will also form a product, when burnt at a temperature of 1600 to 1650 degrees C., which will slake with water only after a period of eight days has first elasped while it is in constant contact with the water. The investigations which were made by W. E. Emley (see United States Bureau of Standards Technical Paper No. 16, year 1913) are in direct contradiction of the former experiments, for this investigator found that it was practically impossible to produce an overburnt lime from a pure limestone. Other investigators have claimed that an overburnt lime can be obtained from limestone which contains as little as 6.27 per cent of silica, when the limestone is burnt at the ordinary temperatures. (See Jahr. Chemie, I, 1897, pages 766ff.)

As is well known the solubility of lime in water varies and is a very difficult matter to determine. Furthermore, this solubility decreases as the time period of contact of lime and water increases. The rapidity of the slaking process depends on the rapidity of the solution of the lime, on its hydration.

The author has studied the rapidity of the solution or slaking of lime and the relation between this solubility and the temperature, and has accordingly established the influence of the various ingredients that are mixed with the limestone on the rapidity of solution or slaking. The method that was used in these studies was the determination of the electrical conductivity of the solution.

The starting material was calcium oxalate (made by Kahlbaum), which was ignited in an electric furnace at temperatures of 600, 700, 800, 930, 1000, 1100, 1200, 1400 and 1700 degrees C., the heating lasting for two hours in each case. In many of the experiments the heating was eected with the aid of the oxyacetylene flame or in the electric arc. The duration of the latter experiment was thirty minutes.

The determination of the electrical conductivity was carried out at a temperature of 20 degrees C. in a glass vessel which had a cubic content of three hundred cubic centimeters. The flask was provided with a thermometer and with a screw agitator which was driven by a small electric motor. The electrical conductivity was established under good mixing conditions at 3000 r.p.m. The increase in the temperature was measured in tenths of a degree and taken into consideration in carrying out the calculations.

In order to determine the quantity of lime that is required to maintain the solution in the supersaturated condition, 0.07 gram of calcium oxide which was obtained at a temperature of 1000 degrees C. was first mixed with one hundred cubic centimeters of water. After constant electrical conductivity of the solution had been obtained, an additional amount of lime, which was burnt at the same temperature, was added, and then the process was repeated again in the same manner until a supersaturated solution was no longer obtained. The results are given in the following tabulation.

TABLE No. 1

Ignition Temperature of CaO—100 degrees C.

Quantity of CaO in 100 cubic centimeters of Water, in grams	Specific Electrical After One Minute	Conductivity $.10^{-6}$ Final
0.07	2692	4440
0.05	5498	6897
0.05	7892	8963
0.05	8999	8971
0.20	9795	8971

Hence, 0.17 gram of lime in one hundred cubic centimeters of water gave a solution of constant electrical conductivity. A further addition of lime first increased the electrical conductivity, but after a certain period of time had elapsed, this was again reduced to the constant value, which indicated the formation of a saturated solution of the lime in water.

An excess of 0.75 gram of lime in one hundred cubic centimeters of water was used in the next experiments. The vessel which was employed in the determination of the electrical conductivity was tightly closed in order to avoid the carbon dioxide in the air from coming in contact with the solution.

The results of the determination of the speed of solution or slaking in relationship with the burning temperature are given in table number 2.

It is easy to see from table No. 2 that the lime

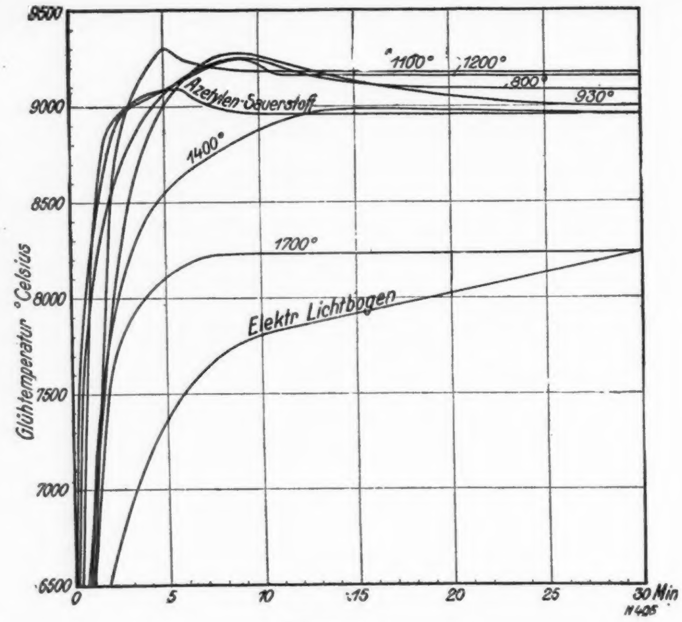


Figure 1

which is burnt at a temperature of 600 and 700 degrees C. forms a solution whose electrical conductivity is considerably lower, due to the fact that at these temperatures the limestone has not been completely converted into lime. The electrical conductivity first increases at the other temperatures up to 1700 degrees C., then reaches a maximum point, and thereafter gradually decreases and finally becomes constant. The decrease of the electrical conductivity after a certain definite period of time has elapsed can be satisfactorily explained by the fact that the concentration of lime hydrate decreases in the solution in combination with the phenomenon of crystallization, and partly as well by the fact that the carbon dioxide of the air acts on the lime, converting it into carbonate of lime.

The curves which are shown in figure 1 illustrate these phenomena in graphical form. The time periods are plotted as abscissae and the electrical conductivity as ordinates.

The electrical conductivity is governed by the concentration of the calcium and hydroxyl (OH) ions in the solution. The higher the electrical conductivity, the greater the hydration of the lime, and hence the more the lime has dissolved. Hence the

TABLE No. 2

0.75 gram of lime mixed with one hundred cubic centimeters of water.

Specific Electrical Conductivity 10^{-6} after Following Minutes:

Burning Temperature of Lime in Degees C.	1	2	3	4	5	6	7	8	9	10	11	15	30	60	24 hrs.
600	1447		1557	1633	1705	1764		1851		1941	2033		2613	2692	2684
700	1233	1688	2156	2275	2367	2451	2547		2636	2668			2750	2398	
800	7941	8383	8768	8971	8960	9135	9178	9221	9264	9221	9178		9096	8982	8560
930	6897	7814	8422	8811	8971	9096	9217	9268	9261	9257	9234		8971	8985	8573
1100	6586	8310	9053	9178	9307	9240	9191	9187	9182	9178	9178		9173		
1200	8153	8768	8970		9090	9135	9164	9221	9264	9218	9170		9168	8970	8584
oxy-ac.	8020	8889	8962	9053	9096	9089	9010	8975	8973	8971	8965		8963	8927	8567
1400	6828	7813	8163	8422	8573	8650	8690	8695	8768	8889	8927	8996	8968	8889	8561
1700	6582	7580	7882	8041	8108	8191	8216	8220	8223	8227	8231		8234	8236	8359
arc.	5918	6617	7049	7170	7386	7481	7611	7744	7779	7813	7848		8236	8238	8271

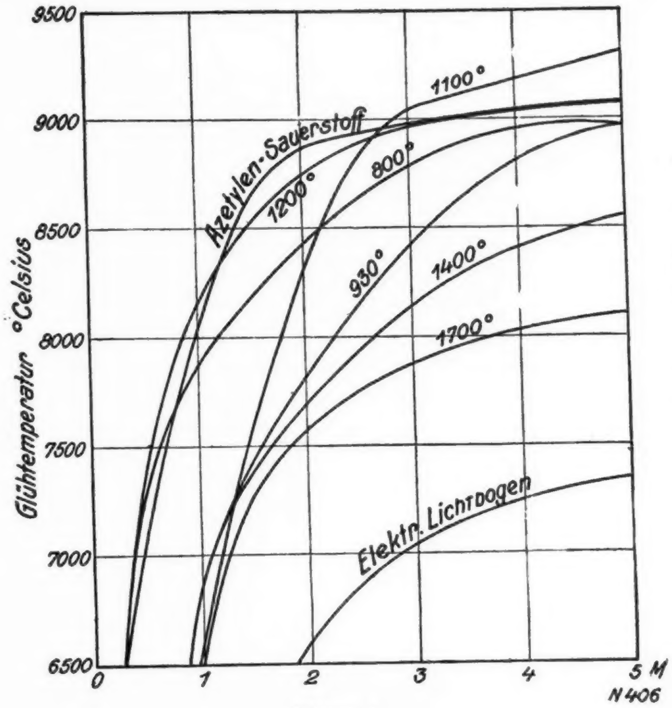


Figure 2

electrical conductivity is a measure of the time of solution. The curves show that the greatest speed of solution is obtained with lime which has been burnt at a temperature of 1100 degrees C., for the reason that the maximum electrical conductivity was obtained within a period of five minutes. The speed of solution for lime which has been burnt at a temperature of 800 degrees C. is nine minutes, for lime burnt at 930 degrees C. eight minutes, for lime burnt at 1200 degrees C. nine minutes and for lime burnt at 1400 degrees C. fourteen minutes.

The curves for lime which has been burned at a temperature of 1700 degrees C. show a very slow solubility, and this also applies to the lime which was burnt at the temperature of the electric arc. The temperature of burning in the oxyacetylene flame was not determined, but it may be established by interpolation in accordance with the course of the curve, that this temperature is approximately 1200 degrees C. The maximum solubility of the chemically pure lime, which was obtained at a temperature of 1100 degrees C, set in after a period of five minutes had elapsed. The curves which are shown in figure 2 serve for the purpose of comparison of the speed of solution of limes which had been burnt at various temperatures, the determinations being made after a period of five minutes or rather up to a period of five minutes.

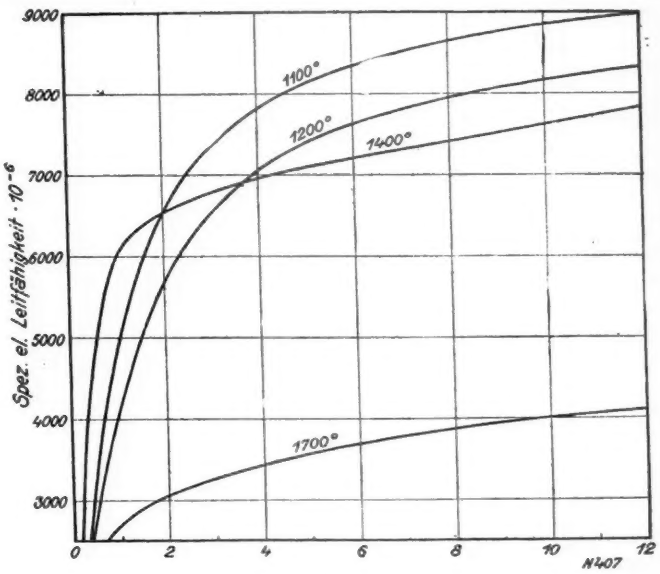


Figure 3

In order to determine the solubility of lime which has been obtained by the burning of natural limestone at various temperatures a product which had the following composition was employed: Calcium carbonate 97.78 per cent, magnesium carbonate 1.72 per cent, iron oxide plus alumina trace, silica 0.07 per cent and water 0.60 per cent, total 100.17 per cent.

The limestone used in these experiments was ground to a fine powder in an agate mortar and sieved through a screen of 4900 mesh per square centimeter, then burnt at various temperatures and thereafter ground once again.

The results are given in table number 3.

It is seen from this tabulation that the electrical conductivity of the burnt natural limestone is less than that of the chemically pure lime which is burnt at the same temperature.

The curves in figure 3 show these results in graphical form.

The maximum speed of solution, that is, twelve minutes, was obtained in the case of a lime which was obtained by burning natural limestone at a temperate of 1100 degrees C. The maximum speed of solution at a temperature of 1200 degrees C. is twenty-three minutes, and at a temperature of 1400 degrees C. fifty-one minutes, and at a temperature of 1700 degrees C. the solution of the lime is not completed even after a period of three hours has elapsed.

TABLE No. 3

0.75 gram of lime dissolved in one hundred cubic centimeters of water.

Specific Electrical Conductivity 10^{-6} in Minutes

Burning Temperature of Lime in Degrees C.	1	2	3	4	5	6	7	8	9	10	11	12	23	31	51
1100	4872	6504	7355	7848	8094	8202	8271	8461	8651	8811	8827	8974		8971	
1200			6561	7018	7321	7580	7813	7917	8094	8163	8236		8781	8773	
1400	6012	6504	6872	6928	7049	7079	7230	7386	7481	7714	7730		8007	8023	8128
1700	2693	3102	3298	3421	3548	3606	3769	3846	3923	4051	4100	4193	4643	4755	5256

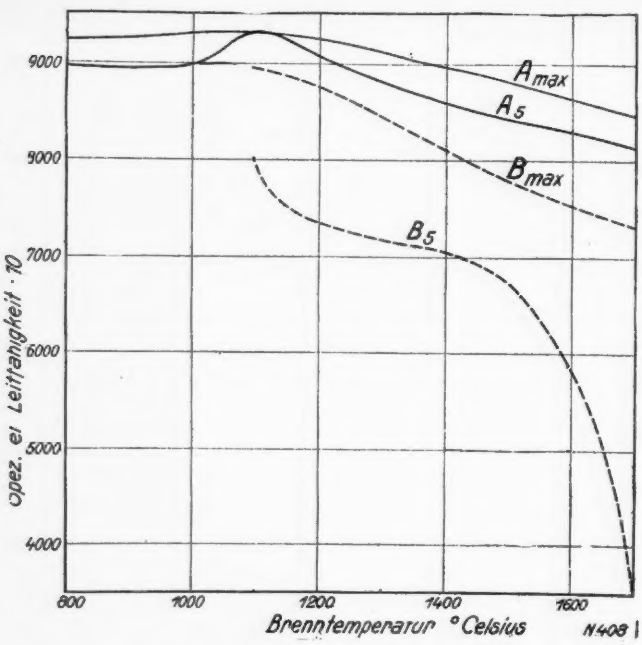


Figure 4

The curves show that no supersaturated solutions are found in the experiments that were made to determine the electrical conductivity of the lime that is obtained by burning natural limestone. This can be explained as being due to the slowness with which the lime dissolved in the water.

Burning Temperature in Degrees C.	One Hour	Three Hours
1100	8967	
1200	8768	
1400	8093	
1700	5477	7355

The curves that are shown in figure 4 represent the speed of solution or slaking in graphical form of chemically pure lime which is obtained by burning the aforementioned natural limestone, the relation of the speed of solution being shown in respect to the burning temperature, the curves being based on the results given in table number 3 and also on figures 1, 2 and 3.

As the temperature at which the chemically pure lime has been burnt increases, the speed of solution of the lime gradually decreases, although this takes place very slowly. (Curve A_{max}—maximum value, A_5—after five minutes.) As the temperature at which the natural limestone is burnt increases, the speed of the solution of the lime obtained decreases to a considerable extent. (Curve B_{max}—maximum value, B_5—after five minutes.)

The investigations which were made on the speed of solution of regenerated lime (which means a lime that has been slaked for a number of minutes and then burnt at the same temperature at which the original burning process was carried out) are given in table number 4.

It is evident from this tabulation that repeated burning of lime which has already been slaked exerts practically no action at all on the speed of the solution of the lime in water. Thus in the first case the lime which has not been reworked dissolves in water after a period of eight minutes, and the lime which has been regenerated twice and three times after a period of ten minutes has elapsed. When the speed of solution was determined in a number of repeated experiments, it was seen that in the first place the electrical conductivity of the lime was less than in the case of the non-regenerated lime, but later the electrical conductivity was increased up to its original value.

As has been mentioned above, the admixture of silica with the lime has a considerable effect on the speed with which the lime slakes, in accordance with the investigations that have been made on this subject by Herpfeld, Robson, Withrow and others. The lime in this case is obtained by a burning process which is carried out at high temperatures and which lasts for a considerable period of time. It therefore follows that the addition of silica must also have an effect on the speed with which the lime dissolves, that is, slakes with water.

In order to determine the action of silica on the speed of solution or slaking of lime, varying amounts of finely pulverized amorphous silica were added to the calcium oxalate which was used in the production of the lime. These proportions of silica were two and one half per cent, ten per cent and twenty per cent, figured on the weight of the calcium oxide, or lime. The mixture was then heated over a period of two hours at a temperature of 1100 degrees C. The product was then ground once more in an agate mortar, and thereafter the mixture was introduced into the vessel in which the determination of the electrical conductivity of the solution was effected. The results that were obtained in the series of experiments are given in tabulation number 5.

TABLE No. 4

0.75 gram of lime was mixed with one hundred cubic centimeters of water.

Specific Conductivity 10^{-6} in Minutes

Burning Temperature of Lime in Degrees C.	1	2	3	4	5	6	7	2	9	10	11	30	1 hr.	24 hr.
930	6897	7814	8422	8811	8971	9096	9217	9268	9261	9257	9234	8971	8985	8573
Twice regenerated				7813	8461	8651	8768	8850	8927	8971	8967	8850	8575	8570
Thrice regenerated	7260	8283	8612	8612	8616	8621	8627	8690	8696	8729	8685	8612	8579	8568

TABLE No. 5

Specific Electrical Conductivity 10^{-6} in Minutes

Addition of silica in per cent	1	2	3	4	5	6	7	8	9	10	11	30	1 hr.	24 hr.
0	6586	8310	9053	9178	9307	9240	9191	9187	9182	9178	9178	9173		
2	6879	7552	8119	8556	8734	8911	8883	8874	8871	8767	8859	8522	8454	8436
5	6834	8110	8548	8781	8916	8906	8877	8873	8867	8852	8848	8734	8725	
10	7453	8454	8802	9057	9062	9240	9246	9205	9171	9132	9062	8877	8768	8717
20	7346	8119	8419	8734	8802	8874	8871	8768	8759	8734	8700	8522	8506	8085

It is clear from the results that are given in the above tabulation that the speed of slaking of lime is not changed by the admixture of two per cent of silica to the lime. However the electrical conductivity of the solution is somewhat decreased when the silica is added. A further addition of silica up to a maximum of ten per cent does not likewise change the rapidity of the slaking process. On the other hand the electrical conductivity of the solution is increased. This phenomenon can be explained by the fact that a supersaturated solution of the lime is formed. It is known that when substances which are soluble in water are subjected to very fine grinding, the pulverized material then has a tendency to form a supersaturated solution in water. The presence of the silica in the lime tends towards the formation of a very finely ground powder.

An additional increase in the quantity of silica that is added to the lime, and even up to a maximum of twenty per cent, has the effect of decreasing the electrical conductivity of the solution that is formed in water. This effect is clearly shown in graphical form in figure 5.

The following important conclusions, which are very significant from a practical standpoint, can be drawn from the results that have been obtained in these series of experiments:

In the first place the lime which possesses the most rapid slaking or solution rate is that which is burnt at a temperature of 1100 degrees C. An increase in the temperature of burning has the effect of gradually decreasing the speed of slaking or solution, but not to any very great degree.

The speed of slaking of the regenerated or reworked lime which is originally and later burnt at a temperature of 100 degrees C. is somewhat less than in the case of lime which has been burnt at the same temperature and is not reworked.

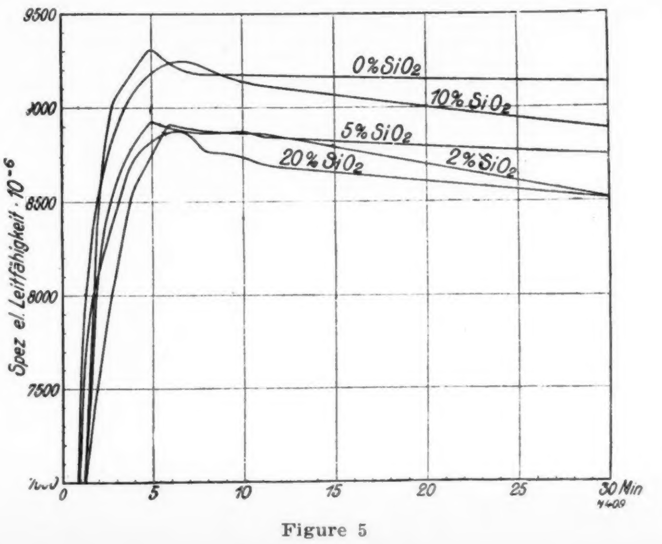


Figure 5

The composition of the original material from which the lime is manufactured has a very marked effect on the speed of slaking or solution. Lime which is obtained from limestone which has been mixed with silica, magnesia, alumina or iron oxide, etc., and which is burnt at the same temperatures as chemically pure lime, will slake at a somewhat lower rate than the chemically pure lime.

Additional experiments should clear up the question of the possible colloidal condition of lime hydrate in solution or slaking (Glasenapp, Zeitschrift fuer unorganische and allgemeine Chemie, pages 195ff, year 1923) which is burnt at different temperatures. These experiments were carried out with the help of the Ostwald viscosimeter and the electrical conductivity was simultaneously determined. The slaking or solution speed of magnesia was determined by the same method. (Iswestia Iw. Wos. Pol. Inst., vol. VIII, 1924, pages 80ff, P. P. Budnikoff and A. Sworykin.)

How to Get Suggestions

The essentials of a successful employees suggestion system are the active cooperation on the part of department heads; publicity that keeps the plan before the employees; a clean-cut statement of purposes and details of the plan; an easy method for submitting suggestions, immediate acknowledgement of the receipt of suggestions; a fair unbiased method of judging them; a satisfying statement of reasons for rejecting them and adequate rewards for accepting suggestions. These essentials are outlined in a report just issued by the Policyholders Service Bureau of the Metropolitan Life Insurance Company.

Suggestions from the workers, ideas that mean more money for both employer and employee not only indicate a progressive organization but also contribute to financial success. The man on the job has a source of vital ideas. Sixty-six well known companies have assisted in compiling this report. The report for getting employees to make suggestions describes methods which have proven successful and discusses the advantages of the suggestion system. Any organization interested in establishing a suggestion system or in learning how other concerns have made their systems successful, will find this report valuable.

The Hungarian Bauxite Industry

Bauxite deposits are located in two districts in Hungary—the northern in the Vertes Mountains, which extend northeast from the southwestern hills of the Vertes almost to the Danube River, and the southern in the Bakong Mountains on the northwest coast of Lake Balaton. It is estimated that the bauxite deposits in these fields amount to 200,000,000 metric tons.

Exploitation has recently begun in the Vertes Mountains in the vicinity of the village of Gant in the county of Fejer. In this district 1,200 to 1,400 tons of ore are produced per day by the use of surface-mining methods. Production for 1927 is estimated at 250,000 to 300,000 tons. The bulk of the ore produced is at present exported to Germany, although a small percentage is utilized in Hungary for experimental purposes. Germany formerly received its bauxite from Istria, but since the establishment of an aluminum factory near Venice these shipments have been discontinued, and the German aluminum interests now depend almost entirely on the Hungarian bauxite. The rapid development of the industry in Hungary dates from the cessation of the Italian shipments to Germany.

Hungarian bauxite exports amounted to only 120 quintals in 1925 and to 721 quintals in 1926. Important exportation began in the present year with the first shipments to the Lautawerke Co., a German firm. According to the Royal Hungarian Bureau of Statistics, 15 metric tons of bauxite ore were exported to Czechoslovakia and 24,007 tons to Germany during the first quarter of 1927. The domestic and export prices of bauxite are fixed according to the quality of the ore and range from 12 to 20 English shillings per ton f.o.b. freight cars at Bodajk station, county of Feher.

There are two corporations engaged in bauxite mining—the Aluminum Ore Mining and Industrial Co. and the Tapolca Mining Co., both of Budapest. The former was established in 1917 to exploit bauxite deposits in Rumania and in 1923 was merged with Rumanian and Italian companies and formed into the Bauxite Trust A. G., with a capitalization of 3,000,000 Swiss francs. The shareholders of the Hungarian corporation obtained the right to exchange their securities for the shares of the newly organized company, which are quoted on all important European exchanges. This company operates the mines at Gant and is in close relation with three industrial companies. The Tapolca company is also controlled by the Aluminum Ore Mining and Industrial Co. and by the Bauxite Trust A. G. Its bauxite fields, however, are not yet under exploitation.

Although at present the bauxite ore mined in Hungary is exported almost entirely to Germany, where it is used by Lautawerke in the manufacture of aluminum, the erection of an alumina and aluminum factory at Csepel (Budapest) for the utilization of domestic ores is planned. In addition, experiments are being made to discover new methods for the production of bauxite cement. These experiments have progressed to date so far that each of the participating coal companies has begun the construction of cement factories and has contracted with the Aluminum Ore Mining and Industrial Co. for supplies of ore. These new cement factories are expected to start manufacturing in 1928, and it is estimated that the first year's combined production will amount to 100,000 tons. The bauxite-ore requirement is estimated at 60,000 to 70,000 tons. Production is expected to increase gradually, and it is hoped to develop an export trade either through direct exportation of cement or through the erection of foreign branch factories supplied with Hungarian ores.

No decision has been reached as yet in regard to a definite manufacturing process for the projected Hungarian aluminum factory. The Lautawerke Company of Germany employs the thermoelectric process and the final results at that factory will decide the kind of machinery and other equipment to be used for the Hungarian aluminum works.

The bauxite-cement manufacturing process as patented in 1908 was not found very practical, since the high cost of the necessary energy made the product more expensive than Portland cement. The associated Hungarian bauxite interests have authorized experimentation in search of a new process for the utilization of the recently discovered bauxite ores of the country, the experiments being financed partly by Government subsidy and partly by the bauxite interests. The bulk of the Hungarian ore is not of the best for the manufacture of aluminum alone. The present process utilizes only such ores as contain a small percentage of silicum and titanium oxides, in order that the cost of production of suitable aluminum oxide may be lowered by utilizing the by-products for the manufacture of cement and extracting the iron.

Experiments with a proposed new process conducted on a large scale in provisional plants especially built for these tests have met with such success that the bauxite cement produced is claimed to be superior to Portland cement as well as to "Ciment Fondu" as produced in the United States and in France.

Cement Superintendent Writes

J. M. Buchheit, superintendent of the brixment mill and quarries for the Louisville Cement Company, writes: "There is as much as fifty per cent more valuable information in the new Pit and Quarry than there was in the old."

GOLDING-KEENE COMPANY BUILDS AROUND MICA, FELDSPAR AND WHITE QUARTZ

By George Ransom

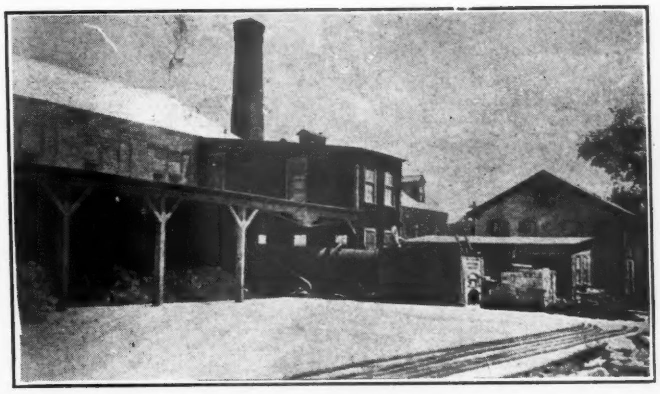
MICA, like asbestos, is one of those peculiar freaks of nature which, on account of its unusual combination of properties, is decidedly exciting to the imagination. Furthermore its uses are so varied and widespread that we encounter it on every hand. In the electrical industry it plays a most important part. The fact that it can be split up into very thin, flexible sheets of even thickness and that its insulating qualities are of the highest order makes it extremely useful for electrical condensers. It can be cut with shears or stamped in almost any pattern by punching machines. Insulating disks, washers, telephone transmitter buttons and a great variety of other shapes are made in this way. To mention only a few uses, it may be said that every lighting socket, every telephone instrument, every electrical household heating appliance, and every radio set makes use of at least some sheet mica.

On account of its transparency and great heat resisting properties we find it used in the glazing of stoves and furnaces and for the manufacture of lamp chimneys for gas and gasoline lamps. And added to this, ground mica, made from trimmings of sheet and run-of-the-mine mica not suitable for sheets, is used for a most surprising variety of purposes. Among these are artificial snow for the decoration of store windows at Christmas time, the lustrous patterns of certain kinds of wall paper, lubricants and many other uses. In other words, there need be no waste material in a mica mine and manufacturing plant. To see how it is mined and handled later on is, therefore, something of vital interest because it closely concerns our most intimate every day life.

As a general thing mica does not occur in sufficient quantities to make the operation of a mine or quarry profitable where this is the sole product. Fortunately, however, it usually occurs in close association with feldspar and in some cases with quartz also, so that if all three of these products are recovered in the mining processes a very profitable operation results.

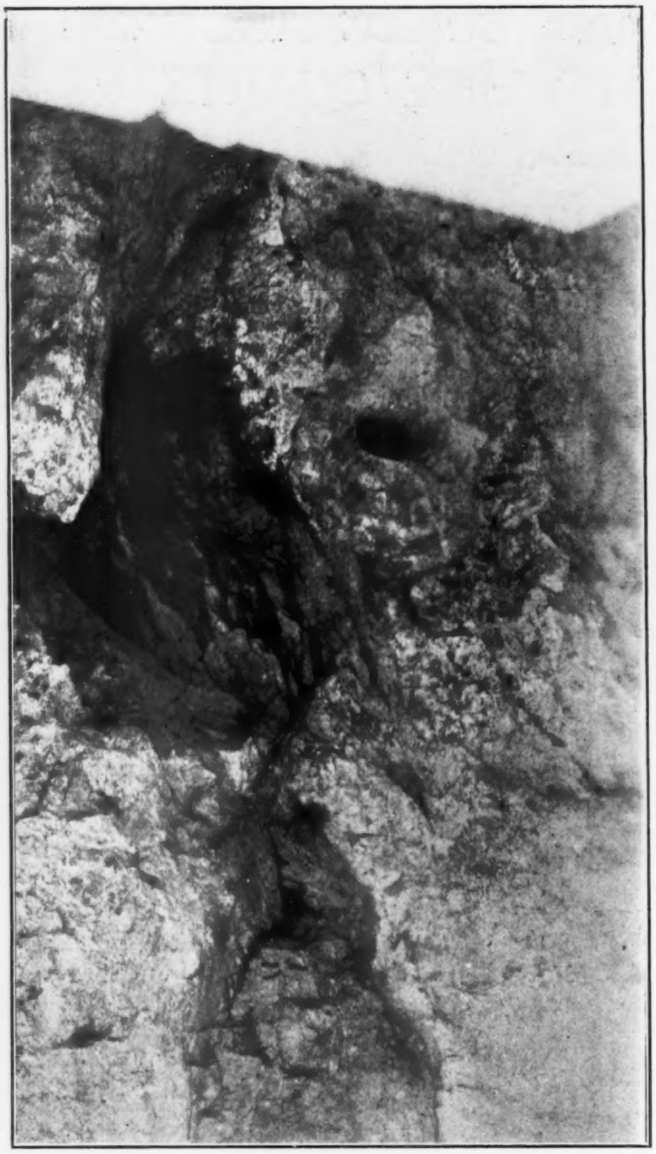
A good example of these cases is the mines belonging to the Golding-Keene Company, of Keene, New Hampshire. This company, through a subsidiary, the Keene Mica Company, handles the mica end of the business and handles directly the feldspar and white quartz. The manufacturing plant is located in Keene and the mine or quarries in the town of Alstead, twelve miles away.

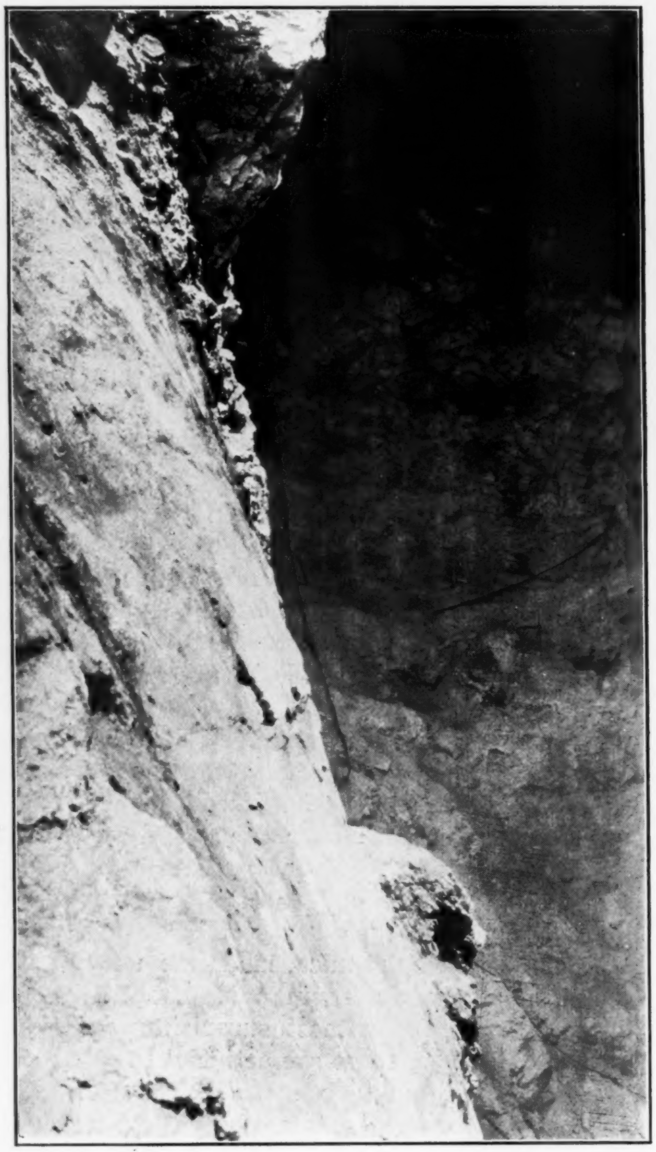
The mines are situated at an elevation of about 1800 feet rather remotely among the thickly wooded hills. There are three grouped closely to-



Rotary Dryer and Storage Yard at Keene Mill. A concrete floor has been provided for the winter storage of crude feldspar

Sorting Belt at which Feldspar is Graded at the Mine





Upper Left—Part of the side wall of the pit showing mica tunnels. Upper Right—Side walls of the pit. Lower—One of the smaller derricks removing refuse.

Loading Skips at the Bottom of the Pit

The Grizzly over the Revolving Screen at the Top of the Feldspar Building

gether. One was opened only a year ago, another two years ago and the third is very old, having been worked for mica for generations. The first two produce mainly feldspar but the old mine produces feldspar, quartz and mica. The Bureau of Mines is authority for the statement that this produces the largest annual tonnage of feldspar of any operation in North America. This mine being of such importance, the following description is confined to it entirely.

The feldspar formation consists of a dike about 1000 feet long, extending northeast and southwest, 75 feet wide and of indefinite depth. Up to the present time operations have been carried down 200 feet and exploration shows that the feldspar continues down to a much lower level. There are some "floaters" of slate but not enough to cause serious inconvenience, although, of course, waste material of any kind costs money to get out of the way. The operation is an open cut quarry.

The mica occurs next to the mica schist walls surrounding the feldspar. It sticks out from the rock like sheaves or leaves of paper and seems almost as flexible. It occurs in much larger quantities these accumulations occur small tunnels are made at some points than at others, and wherever into the side walls. These are shown in some of the illustrations. The "books" are removed by hand with hammer and chisel. At the time of the writer's visit to this mine, which was during the first week in June, there was still so much ice in some of the mica tunnels that they could not be worked. This of course is not true of all the tunnels, some of which have their openings exposed so that the sun can shine into them.

The feldspar, which has occasional veins of white quartz running through it, is taken out in benches. Drilling is done by Denver and Ingersoll-Rand jack hammers. The holes are drilled only 8 to 10 feet deep and eight to ten holes are shot at a time with 100 to 400 pounds of 40 percent DuPont gelatine dynamite. Drilling is done first at one end of the pit and after the blast it is transferred to the other end while the loose stone is taken out from the first.

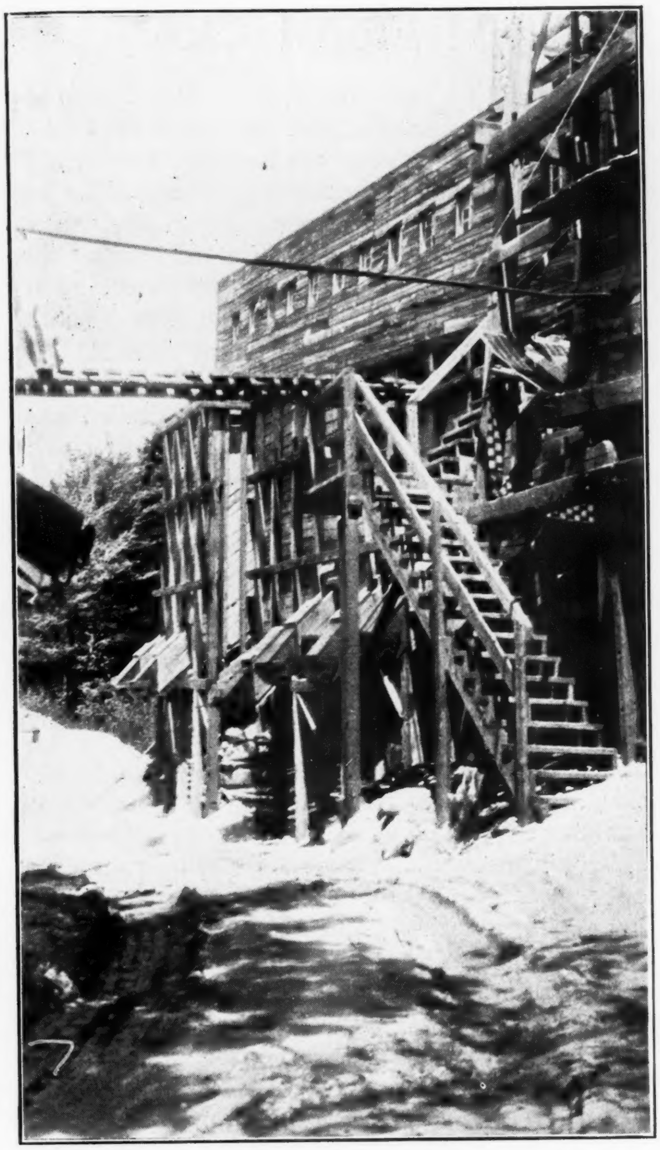
Stone is removed from the pit by means of an aerial tramway and two lift derricks. The larger portion of the stone is handled by the aerial tramway and sorted out of the quarry. However, the facilities originally provided for this purpose have become inadequate during rush times, as at present, so some of the stone is picked over in the quarry and taken up by the derricks for storage in separate bins. Usually the best grade of material is handled in this way. Some of the waste is also removed by the derricks. They are operated by Lidgerwood steam hoisting engines and American Steel & Wire Company wire rope is used through all the quarries. The aerial tramway has a large Lidgerwood steam hoist.

The cableway supports a skip holding 1½ tons. The stone is taken to the top of a building near the edge of the pit and dumped into a chute from which it drops into a revolving screen which removes the dust and pieces too small to be conveniently sorted. This screen discharges on to a sorting belt on each side of which men are stationed to pick out commercial grades of feldspar. Each grade is picked off the belt by definite groups of men and dropped into openings leading to the proper bins. Particular attention is paid to careful and uniform grading, which, of course, is only sensible business policy. The material which reaches the end of the screen is waste and passes to the dump pile. The same is true of that which passes through the revolving screen and which goes to a separate dump. Whenever these waste piles become too large they are removed in small cars to other piles.

Formerly the quartz was treated as waste. Now, however, it is reclaimed in the quarry, hoisted up to the surface by one of the derricks and stored in bins. It is used in the manufacture of glass to permit the passage of ultra-violet rays and in the manufacture of certain kinds of pottery. It is an interesting instance of how a part of the former overhead expense can be turned into a profit.

Steam power is used at present, but plans are being developed for electrification. A Heine marine boiler supplies steam for the Ingersoll-Rand compressor and to a Shipman engine which drives the revolving scalping screen and the sorting belt. The hoists have their own individual boilers and engines. As all of the stone must be trucked to

Upper Left—Looking down into the pit with view of one of the mica tunnels. Upper Right—Mica tunnel still full of ice in June. Lower—Load of material approaching the grizzly over the screen at the feldspar sorting plant



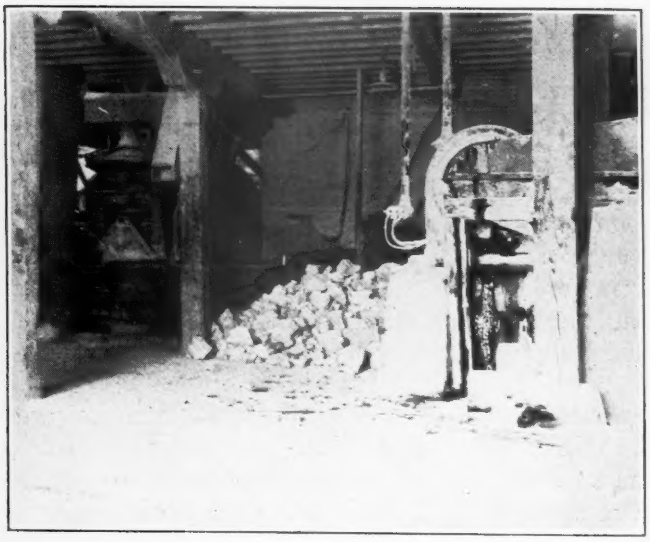
View of Feldspar Storage Bins at Mine

Keene it is a comparatively simple thing to bring back coal for the steam plant in the empty trucks.

Another result of the isolated situation of the mines is the necessity of providing living quarters for a good many of the men. Some, of course, live in their own homes in the neighborhood but others have to be taken care of otherwise. Those having families are given permission to build houses on the company's land and material is supplied to them at cost.

The trucking of stone from the mines to the plant at Keene is done by contract. The trucks, of course, are loaded by chutes from the various storage bins at the mines. Mining operations are carried on throughout the winter and the roads are ploughed out so that the trucks can also run except for about six weeks in the spring while the frost is coming out of the ground. During this period the New Hampshire authorities place an embargo on trucking on all state roads. It is consequently necessary to accumulate a surplus at the Keene plant to keep it in operation through that time.

At Keene there are two distinct plants. One in which the mica is prepared for the customers and one for the grinding of feldspar.



Conical Mills at right and Dryer at left at Keene Mill

The "books" of mica are first cobbed—that is, have the adhering remains of stone removed. They are then split and graded according to sizes and transparency. All this is hand work done at benches. It is a job colling for not many but decidedly intelligent workers, some of whom have been at the job for many years. The mica is sold and shipped in the rough laminations wherever possible, but some customers insist on having it in final commercial shapes. For this purpose a limited number of Bliss presses have been installed.

Mica which is not suitable for sheet work or punching is placed in bags for grinding.

The feldspar is first crushed in Reliance crushers and if wet it is dried in a Ruggles-Coles rotary dryer. It is then pulverized in Hardinge mills. From there it is passed through a Grey Emmerick air separator. A railroad siding passes the end of the mill so that it is a simple matter to load freight cars.

The production of mica, feldspar and quartz in a unified series of operations has economic advantages which are obvious to anyone. It is a more or less general practice in this branch of the nonmetallic mineral industry but as an example of what can be done it may serve as an inspiration in other branches.

Pit and Quarry Aided in Design

W. W. Millar, of the Monongahela Sand and Products Company of Fairmont, West Virginia, writes that both Pit and Quarry and the Pit and Quarry Handbook aided greatly in the preparation of the proposed change in the layout of their plant. He also adds: "They always contain valuable and interesting data and we expect to derive much benefit from them during the operation as well."

MANUFACTURE OF ALUMINUM FROM CLAY

THE United States is one of the largest producers, and one of the largest potential producers, of aluminum and pure aluminum compounds, the United States Bureau of Mines, Department of Commerce, points out. The nation is, however, increasingly dependent on bauxite imported from abroad (chiefly from the Guianas, France, and Dalmatia) for raw material for the manufacture of alumina and aluminum hydrate for use in those industries. For political, as well as economic, reasons it would be well to develop processes looking toward the utilization of other aluminous minerals within our own borders, as Norway, Germany, and Italy have done, even if these processes are then only laid away for use in time of need, as was done, for example, with the Packard process at the Lauta plant in Germany.

The Bureau of Mines has studied available information on the acid extraction processes applicable to clays, leucite, shales, and alunite, and has done experimental work to clear up or corroborate various points in the chemistry or technology of the processes. Because of the secrecy concerning essential points in aluminum production, the Bureau's investigations can not claim to be exhaustive or final, but their results indicate what may be expected of processes for acid extraction of alumina or aluminum compounds from various aluminous minerals, and also indicate the limitations and to a certain extent the possibilities of these processes.

Acid methods of extraction have been improved to the point where both chemical and technological details make possible the production of pure aluminum sulphate and chloride from clays and other aluminum silicates, but economic reasons have caused the abandonment of these methods in favor of the cryolite process, which in turn was supplanted by bauxite. The acid processes were never used to any extent for making aluminum oxide for the manufacture of aluminum, because by the time manufacture from the oxide was developed the acid processes were a thing of the past.

If the bauxite deposits are to be exhausted, as the cryolite is being, or are to be placed under restrictions which amount to the same thing for the individual manufacturer or for this country, it is evident that the old processes must be taken up again or new ones discovered. In the manufacture of aluminum at present there are two main stages: First, the production of pure aluminum oxide (alumina) from some aluminous mineral, usually bauxite, and, second, the reduction of this aluminum oxide to the metal in a bath of fused cryolite.

Pure aluminum compounds, such as the sulphate, acetate, and chloride, are also usually made in two stages—first, the pure aluminum hydrate or oxide is prepared, and then by the action of the sulphuric or acetic acid on the hydrate, or of chlorine on the oxide, the corresponding pure salt is obtained. The reason for these two stages is that impurities in the raw materials must be removed. Bauxite, for example, usually contains alumina, iron oxides, silica, and titania. If it is directly electrolyzed or dissolved, a considerable proportion of these impurities will appear in the aluminum or salts. Hitherto it has proved more practicable to make the pure alumina and then the pure metal or salts than to refine an impure metal or purify crude salts.

Because of the commercial importance of aluminum and its salts, a large number of experimenters have proposed processes for making pure alumina and pure aluminum compounds from various aluminous minerals, such as cryolite, bauxite, clays and kaolins, labradorite, alunite, leucite, shales, feldspar, and others. In accordance with the principle of the survival of the fittest, the mineral almost exclusively worked for alumina and pure aluminum compounds at present is bauxite; it is worked mainly by the Bayer process for alumina, and by acid extraction from alums and lower grades of aluminum sulphate.

There are several reasons why bauxite and the Bayer process may be displaced from their present commanding position, just as bauxite displaced cryolite and the Bayer process displaced the older acid extraction processes and the Morin and Peniakoff alkaline processes. The Bayer process is technically one of the most difficult to operate and control. The filtration problems alone are perhaps as difficult as those in any other technical process. In addition the process is expensive.

Until the outbreak of the World War the supply of suitable bauxite was ample. Since then it has been realized in many quarters that the supply of such bauxite is far from inexhaustible, and that distribution from the existing deposits can be easily shut off in time of war or placed under irksome government and economic control in time of peace. In recent years these economic and political considerations have led to increasing activity in research, especially in Germany, Italy, and Norway, to develop domestic sources of raw materials for making the aluminum oxide necessary to render large aluminum industries independent of foreign control.

Pit and Quarry Exactly His Idea

Fred Beerman, general manager of the Atlas Rock Company, writes to the editor: "Allow me to state that the new Pit and Quarry is exactly my idea of the type of reading matter and editorials that should be contained in a magazine of this nature. At this time I wish to compliment you highly on the exceedingly interesting and helpful magazine which is now being edited by you."

METALLURGICAL LIMESTONE

By Oliver Bowles
Superintendent, New Brunswick Station, Bureau of Mines

Part II

THIS is the second of two articles, the first of which appeared in the July 20th issue of Pit and Quarry. In his first article Mr. Bowles gave some very pertinent information on the way in which limestone is used in metallurgy as a flux, and the requirements of fluxing stone to meet various grades of ore and other conditions of smelting. This second article treats of the problems connected with the quarrying production of fluxing stones and offers suggestions for the solution of some of the conditions encountered.—Editor.

General Features in the Quarrying of Fluxing Stone

The problems connected with the quarrying of fluxing stone are similar in many respects to those encountered in other branches of the limestone industry, such as the quarrying of cement materials, of limestone for lime manufacture, or in the preparation of crushed stone for ballast, highway construction or concrete aggregate. There are, however, certain noteworthy differences. For Portland cement manufacture about one ton of clay or shale is added to each three tons of limestone; therefore, the presence of clay with the limestone may be no detriment, but for fluxing purposes the clay content must be kept as low as possible. Also the raw materials for cement manufacture are finely pulverized, whereas fluxing stone must be in lump form.

The crushed stone industry has one feature in common with flux production in that fines are undesirable, but here the similarity ends. For crushed stone physical properties, such as hardness, toughness and porosity are of greater importance than chemical composition, but for flux the chemical composition is of primary importance.

Metallurgical limestone quarrying is most nearly related to quarrying for lime manufacture, for in both these industries stone of approximately the same chemical purity is demanded. Lime for certain purposes must be made from high-calcium stone, just as open-hearth flux must be of the high-calcium type. For some limes as for some fluxes the admixture of considerable magnesium carbonate is not detrimental. Carrying the comparison further, it may be stated that for certain purposes, as for example the manufacture of plastic finishing lime, a pure dolomite is used, and similarly metallurgical stone for basic open-hearth furnace lining should consist of nearly pure dolomite. The latter rock, however, finds a much more extended use in the lime industry. The close relation of the fluxing industry to the lime industry is well illustrated by the fact that lime is used extensively for fluxing as a substitute for limestone. The similarity between the problems of quarrying metallurgical limestone and rock for lime manufacture is further exemplified by the fact that lump stone is desired in either case. Most of the lime now used is calcined in the shaft kiln, for which purpose stone over 4 inches in diameter is desired. For fluxing purposes a somewhat lower size limit is allowed, stone down to 1 inch being acceptable, the upper limit being 8 to 12 inch stone. In both industries fines are undesirable, and a quarry problem common to each is a reduction to a minimum of the percentage of fines.

Two bulletins[2] already issued by the bureau cover the main features of quarrying for cement and lime manufacture, and another bulletin, the underground mining of limestone[3]. The reader is referred to these reports for a detailed discussion of methods and equipment. Owing to the similarity in the problems involved, the reports covering the raw materials for lime manufacture are of special interest.

Impurities in Limestone

Nature and Effect of Impurities. As pointed out previously the chief impurities in fluxing limestone are silica and alumina, with smaller percentages of sulphur and phosphorus. The presence of a small amount of iron is not generally regarded as injurious. While iron in oxide form is not detrimental, its presence in sulphide form as pyrite or marcasite is undesirable on account of the sulphur associated with it. As previously noted the impurities in fluxing stone are of two types, the sulphur and phosphorus which are injurious to the finished product, and the silica and alumina, which, though they may have some influence on the quality of the finished metal, are for the most part simply dilutents or inactive impurities that are objectionable because they require flux for their removal.

Permissible Percentage of Impurities in Flux. The maximum permissible limit of sulphur in flux is 0.5 per cent, and it is desirable that it should not exceed 0.1 per cent. The upper limit of phosphorus for Bessemer iron is placed at 0.01 per cent and for non-Bessemer iron at 0.1 per cent. In most commercial limestones the sulphur and phosphorus contents are so small that they may be disregarded.

[2] Bowles, Oliver, "Rock Quarrying for Cement Manufacture," Bureau of Mines Bulletin 160, 1918, 160 pp.
Bowles, Oliver, and Myers, W. M., "Quarry Problems in the Lime Industry," Bureau of Mines Bulletin 269, 1927. (In press).

[3] Thoenen, J. R., "Underground Mining of Limestone," Bull. 262, Bureau of Mines, 1926, 100 pp.

Sulphur is more common than phosphorus, for sulphides such as pyrite and marcasite are frequently found in limestone. Due to their yellow color and metallic luster the sulphides are usually easily détected.

The most common impurities, and those that demand most consideration, are silica and alumina. For blast-furnace use no set rules are given as to the permissible percentage of these impurities, but for average practice it is desirable to keep the total impurity under 5 per cent. If a low silica ore is being smelted, a flux with considerably more than 5 per cent impurity may be used if it is low priced. On the other hand a siliceous ore may require a flux having less than 5 per cent impurity. The producer should familiarize himself with the demands of individual furnaces within his market area. For basic open-hearth flux the silica content should not exceed 1 per cent, and the alumina content 1.5 per cent.

Purity of Stone Influenced by Quarry Methods. The above limiting figures may serve as a guide to the quarryman in his effort to produce a flux that will satisfy his customers. With these standards of purity before him the quarryman's task is so to conduct his operations that uniform stone of the requisite purity may be produced. To do so intelligently requires an intimate knowledge of the way in which the various impurities occur, for the manner of their association with the stone has an important bearing on quarry methods. It is important to emphasize that in many instances the quarry superintendent can by careful and intelligent conduct of operations produce a satisfactory flux from a quarry that under less competent management might produce a stone too impure for use. The chief ways in which impurities occur, and the quarry methods involved are discussed in the following paragraphs. Consideration is given only to silica and alumina, the chief impurities.

Impurity an Integral Part of the Limestone. In some limestone deposits impurities such as silica and alumina are present as an integral part of the stone, that is, they are so uniformly distributed throughout the rock mass that there is no practical means of separating them from the calcium or magnesium carbonates. Siliceous and aluminous limestones are the result of uniform deposition of sand and clay particles with the carbonates when the deposits were formed. In dealing with such stone the quarryman is helpless; he must take the rock as he finds it, and seek the most profitable market for it in its impure form. Stone of this character may serve admirably for crushed stone, but if the content of impurity exceeds the limits previously given there is little hope of using it for metallurgical purposes.

Impurity in Seams and Lenses. When the limestone beds were formed, the impurities may have been deposited only at certain places and times, as by eddies, or when swollen and turbid rivers carried down clay and sand. Under such conditions the impurities may be confined to narrow lenses or seams. If such lenses are not numerous, and are visibly different from the main rock mass, they may be separated out in quarrying. If hand-loading methods are followed, the loaders may be trained to recognize the impure fragments and reject them. If mechanical loading methods are employed, the picking belt may be used. This is simply a belt conveyor which carries the sized rock to storage. One or two skilled men stand by the belt and pick off the impure fragments as the rock passes by. One lime operator in Ohio improved the quality of his lime greatly by the use of a picking belt. It is a type of equipment widely used with metalliferous ores, but almost unknown in the non-metallics. It could be used with great advantage in many places. It has a decided advantage over hand selection while loading, for the hand loader is usually employed on a contract basis, and his incentive being tonnage rather than quality, there is a tendency toward carelessness in selection unless strict supervision is maintained. As the belt picker's sole duty is to remove impurities a more thorough elimination of the undesirable fragments is to be expected.

Impurity in Separate Strata. Conditions of deposition when a limestone bed was in process of formation may have been constant over a long period of time, then through elevation or depression of the ancient sea floor, or for some other cause, conditions of deposition may have changed, and limestone beds of a different character may have been formed. Thus the succeeding beds in a ledge of limestone may vary considerably in composition. Some of the beds may be sufficiently pure for metallurgical use, while others may be too impure. The pure and the impure strata may be thin and may alternate in such a way that separation would be impractical, but on the other hand where there are only one or two thick beds of each type separation may be easy. The secret of success in such a quarry is to find a market for each type of stone produced. In one Pennsylvania quarry the upper 40-foot ledge is used for furnace stone and for crushed stone, and the lower 45 feet for lime manufacture. Quarrying in such a deposit should be conducted on two separate benches so that the two types of rock will not be mixed. In such variable deposits, therefore, the different types of stone should be quarried separately as far as possible, and each type should be diverted to the market for which it is best suited. If some beds are unmarketable, and yet must be removed in the process of quarrying, the quarry must operate under the handicap of a high percentage of waste.

Impurity in Overburden. The rock in a quarry may be well above the standard of purity demanded for furnace use, but as delivered to the customer it may contain too much impurity as the result of contamination with an overburden of clay or sand. Such a condition is no fault of the stone itself, and responsibility for it must be laid at the door of the quarry operator. Clean stripping is highly desirable at every metallurgical limestone quarry. The presence of erosion cavities involves difficulties that are considered in the section of this report immediately following. Wherever possible the overburden should be stripped before the rock is shot down. At many quarries, particularly where the covering is thin, the overburden is shot down with the rock, a method which accounts for much of the contamination in furnace stone. In wet weather soil so adheres to the rock that even with the most careful hand loading some sand and clay are sent to the furnaces with the stone. Even in dry weather the loading of fine materials with a fork often results in considerable soil being loaded with the rock. If loaders are urged to keep the rock pure they may go to the other extreme and leave much good rock mixed with the soil. The shooting of rock and soil together, and making a separation at the quarry floor, has very little to recommend it, and has much in its disfavor.

Where machine loading is followed the separation of rock and soil is accomplished by screening. The screen is undoubtedly more efficient than the fork, but the presence of oil with the rock may result in some contamination, particularly in wet weather.

Impurity in Erosion Cavities and Pockets. Where an overburden of clay or sand rests on a smooth rock surface the problem of clean stripping is simple. However, as limestone is slowly soluble in water containing carbon dioxide, usually the rock surface is irregular with many clay-filled cavities and pockets. This makes stripping difficult, and complicates the process of quarrying a clean stone. The clay-filled fissures may descend many feet below the surface, and may be so narrow and deep that removal of clay from them becomes difficult or impossible. The surface cavities may be cleaned out by hand methods with pick and shovel, a slow and costly process. Under favorable conditions the soil may be washed out by hydraulic methods. It is inevitable, however, that in quarries of this character some soil must be shot down with the rock, and the problem is to decide on the best means of making a subsequent separation. As with overburden shot down with the stone, the ordinary method is to load the rock by hand, using a fork to separate the smaller fragments from the soil. Where the amount of clay is limited this method may be the best to use.

Some quarries are equipped with washing plants, and a very clean stone is thus produced. Considering the heavy expense of removing clay from the seams and pockets, and the desirability of making a clean separation at the quarry floor, a washing plant may be the best solution of the problem. With an efficient washing plant at a quarry with a light overburden, the stripping charge may be eliminated, rock and soil shot down together, loaded with mechanical shovels, crushed, and the soil removed by washing during the screening process. Such methods are now employed successfully, but they require heavy capital investment, and on this account are not adapted for small operations.

Permissible Limits of Magnesium in Furnace Stone. The effects of magnesia in fluxing stone have already been mentioned. For blast-frnace flux considerable latitude is allowed in the percentage of magnesium. Magnesium is probably about as efficient as calcium for slagging off silica and alumina, though there is some uncertainty and difference of opinion on this question. For removing sulphur and phosphorus calcium is most effective. High-calcium stone is usually preferred. The magnesium content of the average fluxing stone does not exceed 10 per cent, but there are no fixed specifications. The fluxing stone producer must be guided chiefly by the preference of furnace operators within his market area.

In basic open-hearth steel practice a flux is added chiefly for the removal of phosphorus, and as calcium is more efficient than magnesium in this respect the magnesium content of the flux is restricted to 5 per cent. In copper and lead smelting magnesium seems to have no detrimental effect, and no limits on the magnesium content are specified.

For basic open-hearth furnace lining a pure dolomite is desired. However, no rigid specifications have been provided, and stones with a $MgCO_3$ content as low as 35 per cent are used.

It is evident from the above that for the larger uses the presence of a small percentage of magnesium is not detrimental, and need cause the fluxing-stone producer no concern. For two important uses, however, the magnesium content should be under fairly close control; for basic open-hearth steel flux it should not exceed 5 per cent, and for lining and patching furnaces the magnesium content should be as high as possible. In quarrying for either of these uses the magnesium content of the stone is a problem of primary importance to the operator.

Magnesium as a Quarry Problem. Where high-calcium and high-magnesium stones occur in separate deposits of reasonably uniform composition the magnesium problem presents no serious difficulty. Where both types occur in the same quarry complications are likely to occur. The least complex condition is where the two types occur in separate and easily distinguishable beds. If dolomite were a product of primary deposition such a condition would be more general, and the problem of quarrying high-calcium and high-magnesium limestones and keeping them separate from each other would be greatly simplified. The occurrence of magnesium may however be very erratic, certain parts of an otherwise uniform bed being dolomitized while other parts are high in calcium. The difference may be recognizable by chemical analysis only, on which account the process of quarrying a pure stone is greatly complicated.

No definite rules can be given for quarrying mixed deposits. If the two types occur in separate beds it may be possible to quarry them on separate benches. If there are thin beds or lenses of high-magnesian stone in a high-calcium deposit, and if the magnesian stone can be distinguished from the main mass and recognized on sight, it may be eliminated by hand picking while loading or removed from a picking belt by the method described previously. If the dolomite occurs in irregular pockets and can not be recognized on sight, the problem of separation may be so difficult that the owner would be justified in diverting the product to some use where the presence of magnesium would be of little or no consequence.

Quarrying to Maintain Uniformity in Rock Composition

Uniform Composition Desirable. In all metallurgical processes of today more and more attention is being given to technical control, to the maintenance of uniform conditions of firing, to exact determination of the charge, and, what is of primary importance to the flux producer, to careful control of the composition of each constituent of the furnace charge. The furnace may be operated most economically when a proper balance is maintained between the various constituents. Variations in the composition of one constituent from time to time as successive furnace charges are proportioned tend to throw the whole charge out of balance. The effect is most noticeable where variations occur in the percentages of impurities, for one of the chief functions of furnace operation is the removal of impurities. Therefore, even small variations in the silica and alumina content of the flux may have a marked effect on furnace practice, and it is highly desirable to have a flux that may be depended upon as having a uniform composition from day to day.

Quarry Methods and Conditions Resulting in a Variable Product. The ideal limestone deposit for flux production is one that has an abundance of rock possessing a high degree of purity and uniformity in composition. Many deposits, however, are less fortunately circumstanced; variations may occur in the quality of the rock from point to point within the quarry. In quarrying such variable rock it is a real problem to work out the most logical method of obtaining the greatest uniformity in the product. Incomplete stripping with subsequent soil contamination during loading is a prolific source of fluctuating quality. In other quarries changes in quality may occur through loading rock exclusively from a high silica bed at one time, and from low silica beds at other times. If unavoidable variations occur in rock composition in different parts of the quarry, it is desirable to obtain an equal distribution of impurities throughout the entire rock mass as shipped, so that the furnace operator may depend upon having a rock of uniform composition for each successive charge. Methods of maintaining a desirable uniformity in the product are discussed in the following paragraphs.

Avoidance of Overburden Contamination. As previously stated most limestone deposits are covered with varying amounts of clay, sand or gravel, and it is highly important that as little as possible of this debris be mixed with the fluxing stone. The chief constituents of such materials are silica and alumina, the same compounds which constitute the chief impurities in iron ores and for the removal of which the flux is added.

Clean stripping of the surface prior to blasting, and as complete removal as possible of clay and sand from seams and pockets, constitute a long step toward the maintenance of uniformity in the quarried product.

Method of Quarrying Flat-lying or Moderately Dipping Variable Beds. Quarries are commonly located in a series of flat-lying or moderately dipping beds that vary somewhat in chemical composition. Due to its mode of origin limestone in a single bed or zone of deposition is inclined to be fairly constant in composition over wide areas, the greatest variations occurring in passing from one bed to another. A series of beds, while varying considerably from each other in composition, may still all be within the limits of purity demanded for fluxing purposes. All the beds of the series may, therefore, be used, but care should be exercised to quarry in such a way that the stone as shipped will be uniform in composition. For example, a ledge may consist of one bed containing not more than 2 per cent impurity and another bed containing 4 or 5 per cent impurity. If these beds are quarried and loaded separately the rock supplied to a furnace at one time may differ considerably from that supplied at another time. If the same furnace burden is maintained for both types of stone inefficient furnace operation will result. The fluctuations in quality may occur so irregularly that changes in furnace burden to compensate for the changing impurity could be made only with great difficulty and at heavy expense for frequent analyses and constant supervision. At some quarries the variable beds are worked separately, and uniformity is maintained by carefully alternating the quarry cars from the different benches as the stone is loaded into bins or railroad cars.

If the quarry face consists of a series of variable beds it is usually best to work them in a single bench, and to shoot down the rock in such a manner that the materials from top to bottom of the quarry may be mixed as thoroughly as possible. The usual method is to throw down the rock by heavy blasts in churn-drill holes sunk to the full depth of the face. A thorough mixing of the rock from the various beds may not be possible by blasting only, but further mixing may be accomplished by proper arrangement of tracks and by judicious operation of shovels. If fairly uniform mixing can be brought about by these means the composition of each carload of stone will approximate the average composition of the entire face, and all carloads will closely approach the same composition.

Hand loading permits more uniform mixing than power-shovel loading, for even though the mass of broken stone may vary greatly from place to place, hand loading units may be employed at many places simultaneously. As the rock is unloaded into bins or railroad cars the successive dumping of quarry cars loaded at different places results in a mixture of uniform composition.

Methods of Quarrying Steeply Inclined Variable Beds. In mountainous districts, as for example in the Appalachian belt of Eastern United States, limestone beds are rarely flat-lying, earth pressure having folded them until the beds in many places stand at steep angles. If successive steeply inclined beds vary in composition, though still within the limit of purity demanded for furnace use, the production of a uniform fluxing stone may involve considerable difficulty. Usually the quarry face is maintained in one of two positions, either parallel with the strike or outcrop of the beds, or at right angles to the strike.

Where the face is maintained parallel with the strike, it advances across the beds with each successive blast. Thus new beds may be encountered and some beds formerly used may disappear. If the successive beds vary in composition, evidently each advance will cause fluctuations in quality. Similarly if the quarry is deepened new beds will be encountered and old beds will successively disappear.

Where the face is maintained at right angles to the strike with each successive blast, the same beds are encountered in exactly the same relative position, and the average composition of the rock from the entire face should not change appreciably as the quarry is enlarged. For uniform production, therefore, it is desirable that the face be maintained at right angles to the strike.

Another factor on which uniform mixing depends is the loading method. If a single power shovel is employed it can work at only one place at a time, and the composition of the rock loaded will undoubtedly fluctuate as the shovel advances from point to point on a wide face. If several shovels load at intervals along the face more uniform mixing is attained. If hand loaders work at successive points along the entire face, and the quarry cars are unloaded in proper succession, it is probable that more uniform mixing of the rock can be attained by this method than by the use of mechanical loaders.

If the usable beds are of limited thickness so that a narrow face must be maintained, the desired uniformity in the product may be obtained by deep-hole blasting and by loading with either power shovel or hand methods.

In summarizing the methods of obtaining uniform flux from steeply inclined variable beds it may be emphasized that the quarry face should be maintained at right angles to the strike of the outcrop, that the rock should be thrown down in a single bench across the entire face wherever practicable, and that a loading method be pursued which will further mix and uniformly proportion the rock fragments from the various beds.

Influence of Mining Methods. As noted in a recent bulletin[4] of the Bureau of Mines there is a marked tendency toward underground mining of limestone. The most noteworthy effect of this method is the increased purity of the stone obtained. In mining it is customary to follow the desirable beds only, and thus avoid the introduction into the product of rock from impure strata. Furthermore, as the whole process of stripping is avoided there is no contamination from surface debris. Operators of mines have been able to find a fluxing market for their fine materials, for they have been able to convince the furnace operators that their fines are just as pure as their lump rock. The general tendency of underground limestone mining is to produce metallurgical stone of a high degree of purity and uniformity.

By-Product Industries

Usually the quarryman prefers a single market for his product, a market all the details of which he thoroughly understands. A diversity of markets requires an additional sales force, and a knowledge of the requirements of other consuming industries. However, conditions may be such that a diversity of products is unavoidable. Stone unsuited for metallurgical use may be so interbedded that its removal becomes a necessity, in which case it is highly desirable that a market be found for it. The crushed stone and railroad ballast industries may constitute favorable outlets. At practically all fluxing-stone quarries there is a surplus of fines. With suitable grinding equipment the fines may be prepared for the agricultural limestone market or for the filler trades. Coarser materials may be sold as chicken grit or as limesone sand in localities where silica sand is not abundant.

Metallurgical limestone is itself a by-product at many limestone quarries. Thus in the Toledo district of Ohio many thousands of tons of dolomite, too small in size for calcining to lime in shaft kilns, is sold to metallurgical plants for furnace lining.

[4] Thoenen, J. R., "Underground Limestone Mining," Bulletin 262, 1926.

Production Cost of Fluxing Stone

Conditions vary so greatly at different quarries that the individual items which make up the total quarry cost are exceedingly diverse, and the total cost at which metallurgical stone may be placed on the market likewise varies markedly in different localities. Therefore, it is a difficult matter to arrive at average costs of the various operations. Thoenen[5] arrived at a cost of 67 cents per ton as an average for 30 open-pit limestone quarries in various parts of the country. For an average quarry operating on a large scale these costs might be distributed as follows:

Stripping	6.0
Drilling	9.5
Explosives	7.5
Loading (hand)	22.0
Mucking	6.0
Transportation	5.0
Repairs, taxes, etc.	5.5
Interest and amortization	5.5
Total	67.0

If machine loading is employed the direct loading cost would be much less than 22 cents, but considering the interest on investment and the crushing and screening subsequently required, the total would probably differ little from the hand loading cost. It is important to emphasize that some of these items will be much higher and some much lower under the particular conditions of individual quarries. If an operator finds that a certain item is very much higher than the figure given above, he should direct special efforts toward developing economies in this particular process. Thoenen's careful study of limestone mining led him to the conclusion that underground work costs on an average about 30 cents per ton more than open-pit work.

[5] Thoenen, J. R., work cited, p. 94.

Progress in Combustion Practices

According to a recent survey of the total output of electric power during last year, about 23 billion kw. hours, or 32 per cent, was produced by water power, the balance of 68 per cent being produced by fuel power. A total of only 260,000,000 kw. hours was produced through the use of wood. To generate the 68 per cent of all electric power produced there was required, in round numbers, a total of 40 million short tons of coal, 10 million barrels of fuel oil, and 47 billion cubic feet of natural gas. These figures represent, respectively, an increase of 7 per cent in coal, and decreases of 38 per cent in oil and 4 per cent in gas consumed over the preceeding year.

The splendid progress in general combustion practices is evidenced by the fact that while increasing power production over 10 per cent, coal consumption increased only 7 per cent, while gas and fuel oil consumption decreased from 1/20th to 1/3rd. Improving power plant practices is one of the sure ways to increase profits since there are no intermediate steps that may absorb the economies. To reduce the amount of coal consumed means to immediately reduce the amount of money paid out.

Business Migrations Being Studied

The Chamber of Commerce of the United States is undertaking an investigation to determine the causes, the consequences and the extent of the migrations of the last year in American manufacture. It aims to present actual figures as to capital, men employed, value of output, and all other details of manufacturing companies in various industries, where loss to one district and gain to another have been a definite development of the last year.

Building Records Broken

Building contracts let in June amounted to $632,478,000 breaking all records according to the report of the F. W. Dodge Corporation. The principal increases over May of 1927 and June of 1926 were in New York, Middle Atlantic States and the Central West. The other districts reported declines.

War on Waste

In discussing this subject in "Manufacturer's News," Frank P. Poole, consulting engineer, states: "The first question which naturally arises in the mind of the manager of an industrial plant, when once he becomes sufficiently aroused to consider seriously his own 'war on waste,' is 'how much waste can I save in my own plant, in dollars?' Every industrial executive today is confronted with many, if not all, of the following questions:

1. High wages.
2. Increasing costs of material.
3. More rigid standards as to quality of products.
4. Smaller sized orders.
5. Decreasing margins between costs and prices.
6. More intensive domestic competition.
7. Faster pace of modern industry.
8. Reduced margins.
9. Increaesed taxation.
10. Likelihood of lower tariff.
11. Growing foreign competition.
12. Difficulty in competing in foreign markets.
13. Seasonal and cyclical ups and downs in volume.
14. Growing complexity and precariousness of modern business.

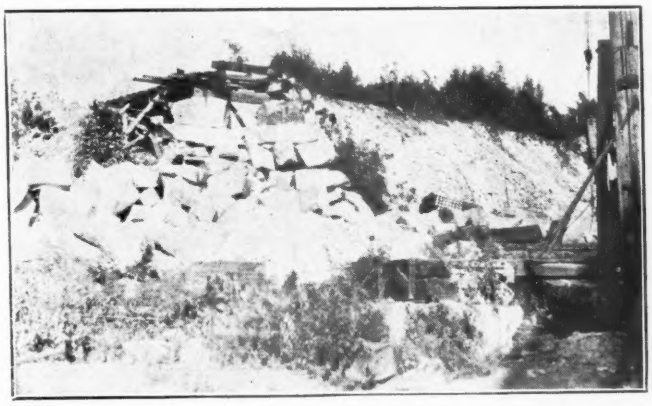
The answer lies in one phrase—Waste elimination."

More than $1,120,000,000 is being spent this year by states and their subdivisions on highway construction, maintenance and bridge building, according to the Bureau of Public Roads at Washington.

WHEN CRUSHED STONE IS A MINOR FACTOR THERE IS A REASON

THE Webb Granite quarry at Marlboro, New Hampshire, is one of the real old ones of New England. It is now owned by Hildreth and Company and the entire output is paving blocks and crushed stone. These paving blocks are shipped to Concord, New Hampshire, and New York City. In fact practically all of the paving of this kind used in the latter city is stone from this quarry as the stone has very even wearing qualities. Recently as much as 20 carloads have been sent out in one shipment and it is expected that the demand may increase materially in the future.

The quarry covers a large area although it is not as deep as some other old ones covering less surface. Methods of taking out rock have been developed in a very intelligent way which takes into account the local conditions. When starting in on a new level a trench is made by blowing one hole at a time, thus making less grout than if a line of holes were shot simultaneously. These holes are charged at the bottom with 3 F powder which is given a covering of sand. Another similar charge, also covered with sand, is placed at the top of the holes. Blasting in this way gives very much the same result as a channeling machine. Another row of holes is then drilled along the back consisting of pairs 8 feet apart. This gives a long straight split without undue shattering. Seventy-five per cent Atlas and DuPont dynamite is used for these holes.

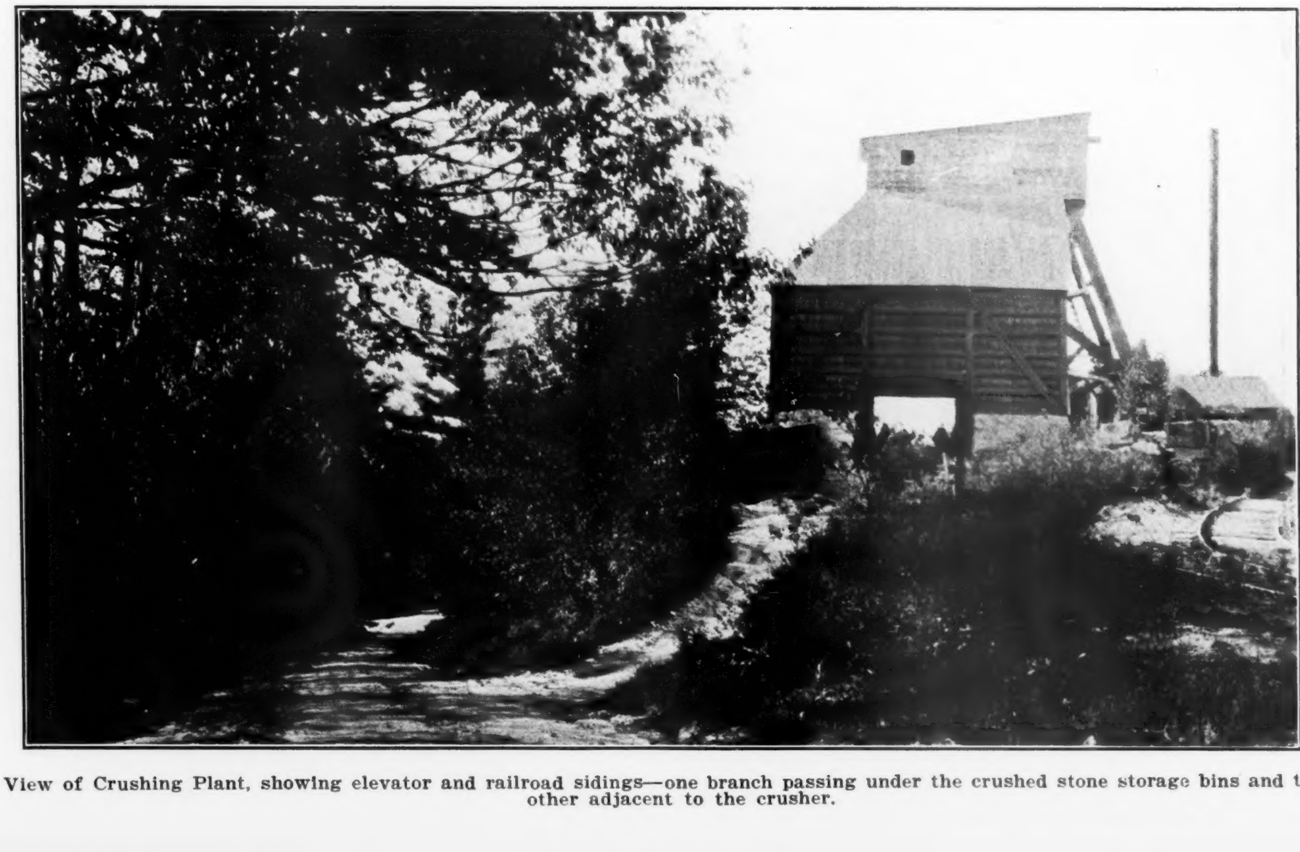


End of Inclined Tracks from Top of Quarry to Crushing Plant. Stone is removed by derrick at right

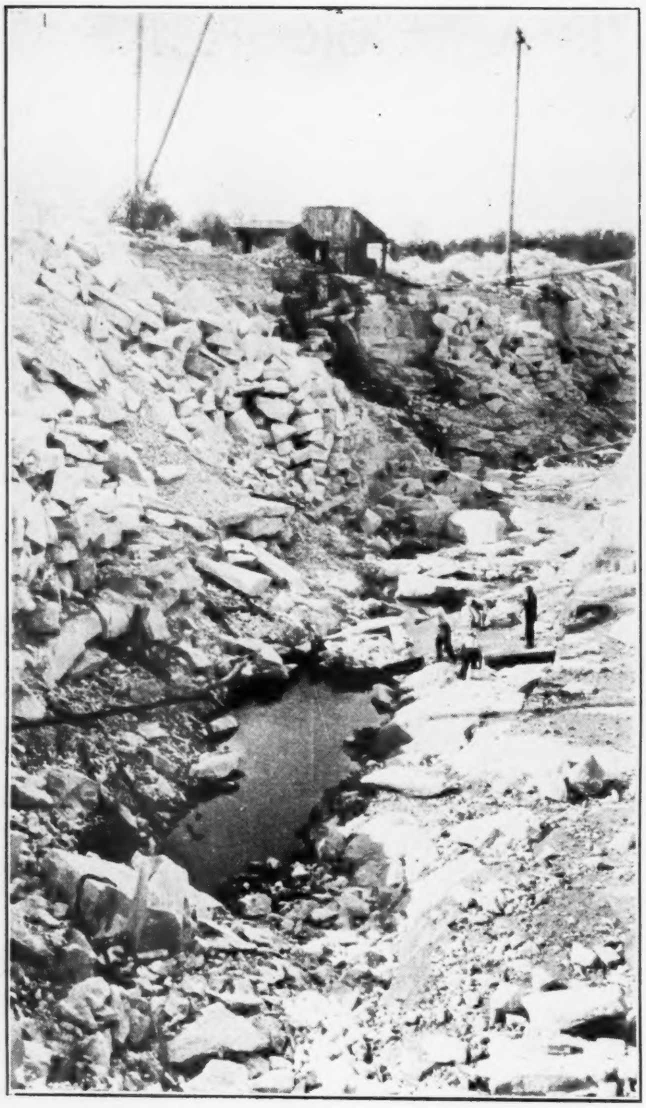
The blocks are then cut off by drilling and splitting. Of course, where material for paving is the end in view, it is not necessary to take out such large quarry blocks as are frequently called for in structural work and this operating detail is naturally taken advantage of. The drilling is done by Ingersoll-Rand jack hammers.

Stone is raised from the pit by three derricks located along one side. Two of these are equipped with American Hoist and Derrick Company steam hoists and the third with a Lambert steam hoist. As much of the paving block cutting as space permits is done at the edge of the quarry. Sullivan air drills are used for this.

A spur from the railroad station at Webb, one



View of Crushing Plant, showing elevator and railroad sidings—one branch passing under the crushed stone storage bins and the other adjacent to the crusher.



Upper Left—Part of the Quarry and Derricks. Upper Right—Elevator from Crusher to Cylindrical Screen. Note box made of old boiler section filled with stone ready to dump into crusher. Lower—Making paving blocks with the help of small drills

Making Paving Blocks

View of crushing plant showing location of crusher and boxes made of boiler sections in which stone is moved by derrick

mile away, has been built up to the quarry so that the blocks may be loaded directly on to freight cars. A rather ingenious way of loading has been devised. Old boilers have been cut in half to form boxes into which the blocks are thrown and when filled they are picked up by one of the derricks and dumped into the cars.

When production is in progress on larger orders the space at the edge of the quarry is insufficient and at such times blocks of stone are placed on cars and hauled to a level spot along the railroad spur by means of the Rhode Island locomotive used for shifting freight cars. A Yale and Towne locomotive crane has been provided by means of which the large blocks are removed from the cars and the small paving blocks loaded for shipment. Unfortunately this particular part of the work was not active at the time of the writer's visit so that it was not possible to photograph it. Sometimes a large gang of men is employed here. The locomotive crane is also occasionally run up to the quarry to clean up refuse.

In addition to the hoists already mentioned there is a Mead-Morrison for moving stock on the tracks at the surface of the quarry and a Kendall and Roberts hoist for letting stone down the inclined track to the crusher on a small flat car. It is usually placed in one of the boxes made of part of a boiler.

A derrick, equipped with a Kendall & Roberts hoist which has been in service a great many years, lifts these boxes of stone from the car and dumps them into the crusher at the crushing plant. There is only one crusher and this is a number 3 Gates gyratory. An elevator raises the crushed stone to the rotary cylindrical screen, which was originally a Gates. Perforated sections for this screen are now secured from the Dillon Boiler Works of Fitchburg, Massachusetts. The sizes of material produced are 2 inch, 1½ inch, 1 inch, ½ inch and dust, which are deposited in separate bins. Tailings from the screen are led by a chute back to the crusher. Shipments are made either by truck or railroad, a branch of the spur having been run under the bins as shown in one of the illustrations. This crushed material is now being largely used for federal aid road construction in the vicinity of Marlboro and neighboring towns.

Power to operate the crushing plant is secured from a Burlingame single cylinder non-condensing engine supplied with steam from a Stewart boiler. In fact steam power is used exclusively. The steam equipment was installed years ago before electrical power was generally available, and for that matter there is now no electrical power line within a considerable distance.

Compressed air for the various drilling operations is supplied by an Ingersoll-Sargent steam compressor unit which has given over 20 years of service and is still in good condition. The steam comes from another Stewart boiler.

This operation struck the writer as a very interesting one. It is situated in a very beautiful hill country and is an old one with much old equipment which has shown how much service it can stand without being worn out. The simplicity of the operations due to the production of nothing but paving material shows what can be done with the right kind of stone, especially when the demand for granite blocks comes into its own again, as there seem to be signs that it will, for certain conditions. The crushing plant is a modern addition greatly increasing the profits and made possible by modern truck highways. The retention of steam power is undoubtedly the conservative thing to do under the existing circumstances.

1926 Farm Income Lowest

The total agricultural income in the United States in 1926 was the lowest received since statistics have been published by the Government. This fact is revealed by a survey recently completed by the Institute for Resarch in Land Economics and Public Utilities of Northwestern University. This research work has been in progress for nearly a year and shows that the agricultural income of the nation was 9.7 per cent of the aggregate income of the entire country.

PIT AND QUARRY FOREIGN DIGEST

Some Modern Machines in the German Concrete Industry

An under-water washing machine is illustrated in Figure 4. The aggregate enters through the funnel into a rotating drum sieve which revolves in a trough of water. The material is driven forward by a helical propeller. The fines are washed into the trough and removed. Another washing machine for grains over 1/10 of an inch is shown in Figure 5. This machine operates on the countercurrent principle, the water and the aggregate entering at opposite ends. A new sorting machine is shown in Figure 6, which will sort a great number of different grain sizes. It is a "sorting cylinder" consisting essentially of a series of wire sieves of different mesh revolving in drum-like compartments.—Schwarz (Zement, June 16, 1927, 495-500).

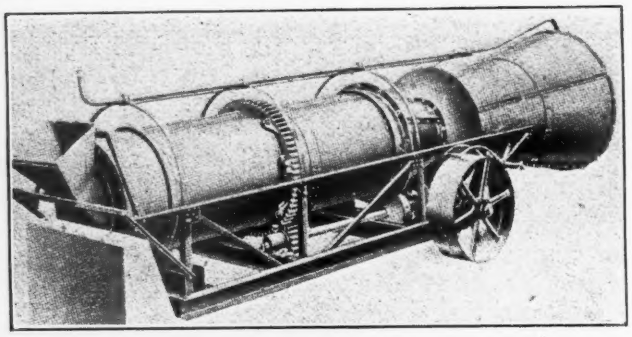


Figure 4

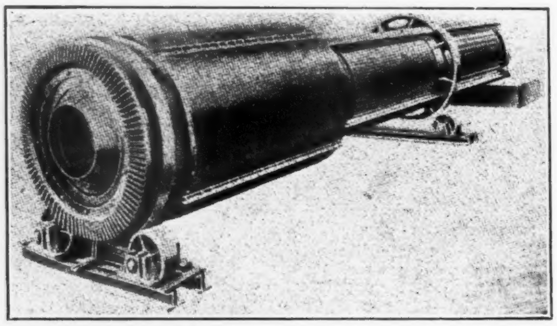


Figure 5

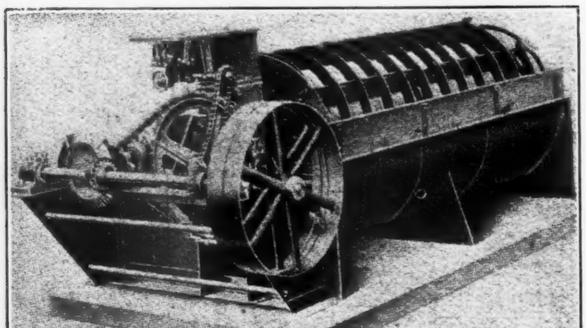


Figure 6

Cellulose Estimation in Asbestos-Cellulose-Cement Products

A portion of the sample, dried at 110 degrees, C., is decomposed with 1:1 acetic acid on the water bath. The residue is filtered on a Gooch crucible containing ignited asbestos, washed with hot water and then digested in the cold at least 1·2 hours with freshly prepared "Kuoxam." In case cellulose is present, it dissolves in the "Kuoxam" and can be separated from the solution by neutralization with sulphuric acid. Upon filtering this precipitate on a Gooch crucible and drying at 110 degrees, the cellulose can be weighed.—Kallauner & Seidl (Zement, June 23, 1927, 509-513).

Foreign Matter and Transformation of Silica

Additions of 2% of various substances of low melting point, and compared with a similar addition of lime, were made to a Welsh quartzite ground to 100 mesh. Samples of the mixtures were fired to cones 9, 12, and 14. Boric acid, potassium carbonate, potassium chloride, potassium chromate, biotite, sodium feldspar, lithium and ferric chlorides facilitate the conversion of the quartz. The densities of mixtures made with 2% lime and 5% of boric acid are not very different but they show pronounced differences in reversible thermal expansions. With increase of firing temperature, some mixtures show an increase, others a decrease of porosity with increase of firing temperature.—Wood, Houldsworth & Cobb (Trans. Ceram. Soc. 25, 289-308).

Aluminous Cement

A variety of aluminous cement may be manufactured by heating a very finely ground and intimate mixture of bauxite and lime or limestone for a long period, usually 8 to 12 hours, at a temperature well below the softening point, that is, below 1,000 degrees C. The burning is performed in a rotary furnace heated by hot air or gases, particularly the waste gases from a Portland cement kiln. The process is particularly applicable to mixtures very poor in lime, resulting in a final product having a hydraulic index of at least 2.—N. B. Voisin (British patent 270,496).

Fireproof Cement

A fireproof cement is produced by mixing 1 to 10 parts of dead burned bauxite in powder form with two parts of cement which contains a minimum of 30 per cent alumina.—P. Kestner (German patent 438,264).

Influence of the Fineness of Division of Trass in Cement-Trass Mortars Upon Their Strength

Three parts by weight of Portland cement were intimately mixed with one part of trass and the mixture agitated with 12 parts of standard sand. The grain size of the trass was graduated from a

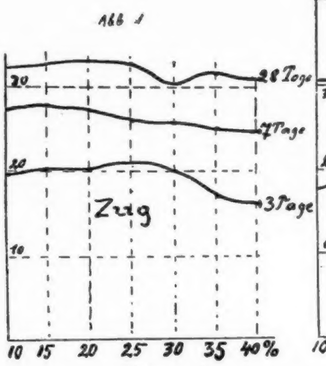


Figure 1

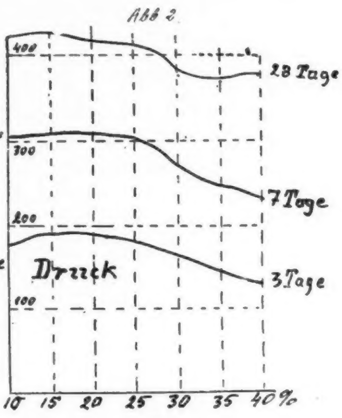


Figure 2

10 per cent residue on the 4900 mesh sieve to the coarsest size of 40 per cent residue on the number 70 testing sieve. The strength of this mixture gives a correct picture of the influence of the trass fineness upon the cement-trass mixture. The tensile strength remains practically constant up to 25% residue. After hardening three days the lowering of the hardening is noticeable only at 35% residue. The crushing strength is affected above 25% residue and the value drops above this figure for all three tests, 3, 7 and 28 days. Figures 1 and 2 show the effects of the per cent of residue on the number 70 sieve upon the tensile and crushing strengths at the end of 3, 7 and 28 days hardening. —Th. Klake (Zement, June 30, 1927, p. 543).

Tests of Rapid Hardening Cements

Rapid hardening cements are lighter than standard Portland cements, the weight of 1 liter of the former, after casting, averaging 1.05 kg., as against 1.16 kg. per liter for the standard. The weights after casting with agitation show a similar difference. The specific gravity of the air-dried and ignited rapid-hardening cements averages 3.16 and 3.18 respectively. Rapid hardening cements begin to set in 2 to 6 hours. The setting interval fluctuates considerably but averages 6 to 10 hours. The tensile strength after three days water curing fluctuates over a wide range but in 75 per cent of the tests averaged 427 lb. per square inch. After seven days the average tensile strength was 470 lb. per square inch. After 28 days this value was 610 lb. per square inch. The compression strength was 500 lb. per square inch after three days water cure, 650 lb. after 7 days and 800 lb. per square inch after 28 days. The ratio of compression to tensile strength was 12 after 3 days, 14 for seven days, and 13 for 28 days curing.—H. Burchartz (Zement, June 30, 1927, 538-542).

Rotary Kiln for Cement Burning

A rotary kiln for burning cement is made with the kiln head and cooler joined together in one piece. The revolving drum (1) (Figure 3) discharges into the outlet head (2) which is driven by rollers (3). The outlet head is built with a

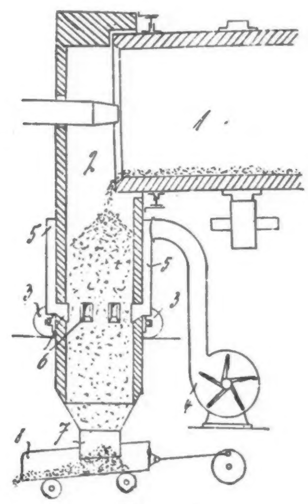


Figure 3

cooling space under it, in which the burned goods enters from the drum (1). To increase the cooling effect, air is blown through the burned hot clinker at this point. (4) is the blown and (5) the air inlet tube. The outlet (7) is an automatic emptying device through which the burned and cooled is removed in a continuous flow from the head (2). —Klöckner-Werke A. G. (German patent application 63,047).

Hardening of Aluminous Cement in Thick Blocks

"Zement" invites communications concerning practical results obtained in the casting of large masses of aluminous cement concrete. According to M. Quinquet, writing in the French "Technique Moderne," the amount of aggregate is not of great importance. He says that large castings of this form of concrete must be made in layers of only 4 inches thick at a time and that three days must always be allowed to elapse before the casting of the next layer. Especially interesting is his advice that aluminous cement be used neither under water nor in subterranean structures, where the water might rise quickly after the casting and expose the concrete to "drowning" before the hardening takes place. Such observations have not been made in Germany.—Anon. (Zement, June 23, 1927, p. 520).

Analysis of Portland Cement

Sampling is done by taking a number of samples, if the volume of the cement is large, mixing them thoroughly and sampling the mixture. If a single bag is to be analyzed, the contents are thoroughly mixed up before being sampled. The sample is ground in an agate mortar until it no longer grates between the teeth. Loss on ignition is determined by heating 2 gm. of cement in a platinum crucible, slowly at first and then with a full flame for 10 minutes. SiO_2 and insoluble matter is determined by evaporating a sample with 1:1 HCl to dryness, and leaching the residue with more acid. The residue is filtered, washed and ignited. The sesquioxides (Al_2O_3 and Fe_2O_3) are determined in the filtrate by precipitation with NH_3. Lime is determined by precipitating calcium oxalate from the filtrate of the sesquioxide precipitate. Magnesia is found by precipitating magnesium ammonium phosphate from the filtrate of the calcium oxalate. The insoluble residue is determined on a fresh sample, by treatment first with HCl, and filtering, and then treating the residue with sodium carbonate solution. The residue from this treatment is the insoluble matter. The acid filtrate is evaporated and used further. Sulphates are determined by precipitating one-half of this filtrate with $BaCl_2$. The other half of this filtrate is used for the Fe determination. The iron and alumina are precipitated with NH_3, redissolved, and Fe determined by titration with permanganate. Free sulphur and sulphide are determined by oxidation of a fresh sample with bromine and estimation again as $BaSo_4$. Sodium and potassium are estimated by usual methods in the filtrate from the calcium oxalate.—Anon. (Zement, June 16, p. 489-490, and June 23, 513-515).

Noteworthy Experience With Concrete From Aluminous Cement

In August, 1925, the foundations of the Elorn bridge at Blougastel near Brest, France, were cast in sea water. After a year the strength of part of the foundations had reached only about one-third of the strength ordinarily obtained. Investigation showed that neither the sea water nor the cement was to blame for this effect, but that the temperature was too high at the time of setting. Aluminous cement generates so much heat in setting that the temperature of the water in water-curing is of great importance if it exceeds a certain maximum. Experiments were made with standard concrete mixes of aluminous cement cured in sea water and fresh water at various temperatures. The strength after definite intervals was determined as well as the temperatures attained in setting. At 35 degrees C., both sea and fresh water show a marked decrease in strength of the concrete. It is useless to expect aluminous cement which has been set in water of too high a temperature to attain a greater hardness than that shown at the end of 24 hours.—O. Syffert (Zement, June 23, 1927, 518-520).

Artificial Stone

The ground residues of asbestos-containing materials, such as serpentine, are agglomerated by means of a suitable binder to produce a stone-like mass suitable for building and other purposes. Preferably the residue is first treated with sulphuric acid. Examples are mentioned illustrating the use of a mixture of sodium silicate and calcium chloride and of tar as binders.—M. Harnisch (British patent 271,108).

Blocks from Silicon Carbide

Silicon carbide powder, either alone or mixed with substances which may form the same material, such as silicon, silicon oxycarbide, silicic acid and coal, etc., is made plastic by addition of tragacanth and molded in a press.—Gebr. Siemens & Co. (German patent 438,065).

Calcining Limestone

In the furnace treatment of alkaline earth carbonates, such as limestone, the material is passed on a pervious support first through a zone of high temperature, and then through a "soaking" zone in which a relatively high temperature is maintained without supplying additional heat. The apparatus comprises a series of charge supports arranged to move on an endless track, the upper horizontal part of which is largely enclosed within a furnace casing. Each charge support consists of a wheeled frame carrying grate bars onto which the charge is fed at the entrance end of the casing. Combustion is effected in chambers at the sides of the track; the heating gases are drawn downwards through the charge by suction boxes, over which the charge supports move. The "soaking" chamber is formed by an unheated continuation of the heating chamber. Preferably two hoppers are fitted, one for supplying a thin layer of inert material for protecting the metal parts of the charge supports from excessive heat, and the other for the charge proper, which may consist of mixed coal and limestone. In a modification the apparatus includes a preheating zone which is heated by the gases from the suction boxes of the main heating zone. The roof of the heating chamber may carry rabbles for stirring the charge.—Dwight & Lloyd Metal Co. (British Patent 269,480).

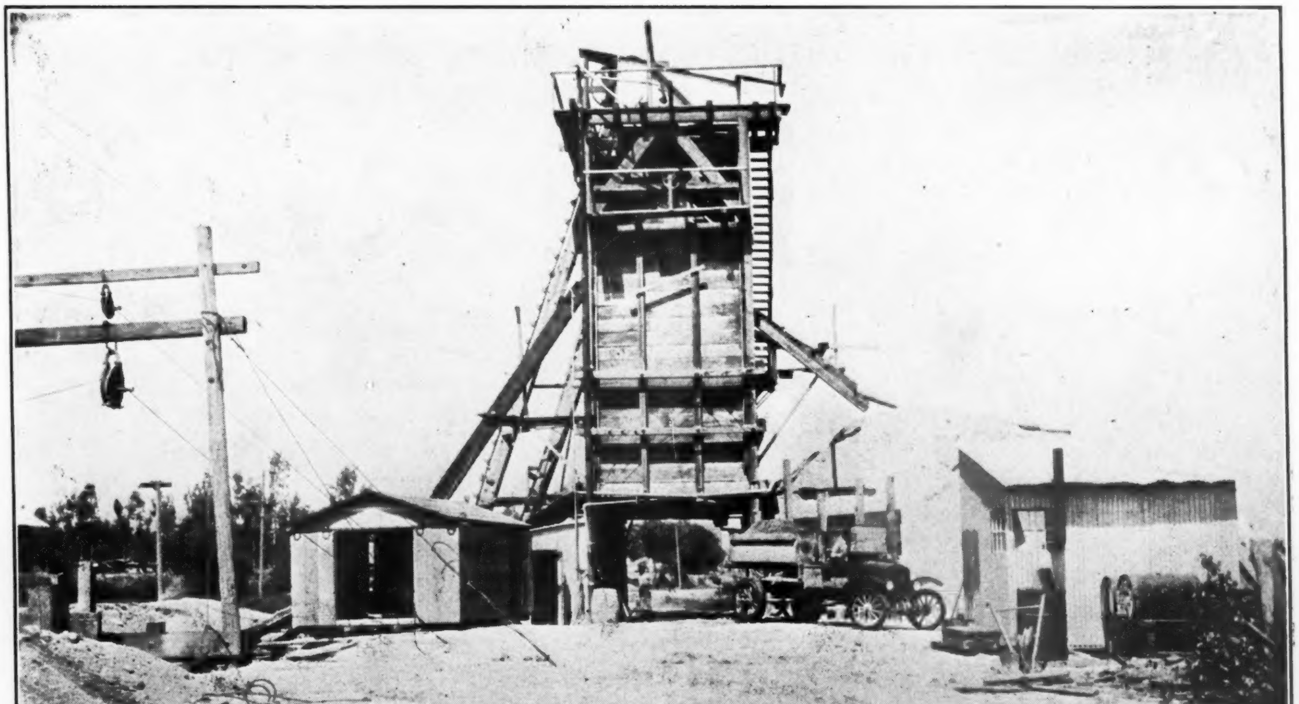
KUSTER AND WATERBURY SOLVE PROBLEMS FREQUENTLY ENCOUNTERED BY OTHERS

KUSTER and Waterbury is a fairly young concern, having been in the sand and gravel business for only three years, the plant being located adjoining the city limits of Corona, California. It is in the bed of the Temescal wash, 50 miles southeast of Los Angeles and 15 miles from Riverside. Like many producers, the company has suffered upsets, most of which, fortunately, have now been overcome. Among the troubles which have been eliminated were some caused by plant engineers, some by salesmen selling goods they had little knowledge of, and some by the producers themselves as they went through the experimental stages of securing the right proportion of sand, rock and buyers.

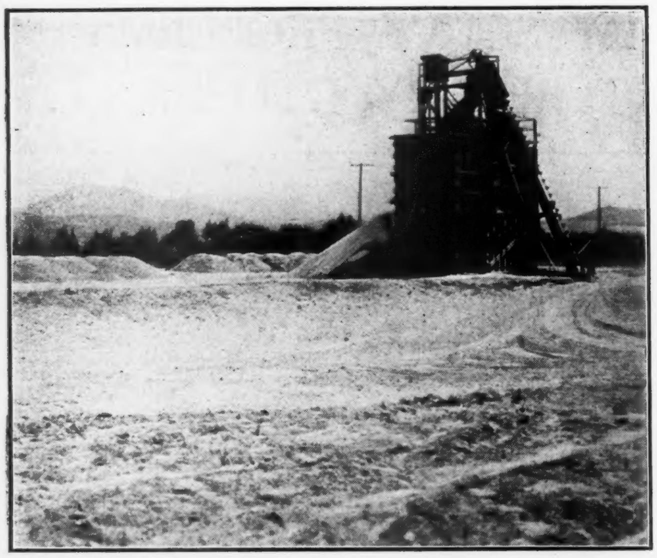
Opening a New Pit at Plant No. 1

Fortunately the company has an excellent quality of both sand and rock to work on and this has held them steadfast to their course even when cloudbursts in the mountains above once filled the pit with vagrant material and twice threatened the plant. The plant is located in a valley which was filled with sand and rocks by a prehistoric stream. When there is excessive rainfall in the hills the valley still floods and the plant had to be carefully placed to avoid destruction by water tearing down the valley.

Number One plant was designed by the Stephens Adamson Manufacturing Company and erected for the purpose of supplying the needs of the local community. It has a capacity of 20 yards an hour and was erected by Stephens Adamson under the supervision of their own engineer. Material is delivered to a Stephens Adamson feeder by a Le Claire drag line, then to a Stephens Adamson



Plant Number One of Kuster and Waterbury



Plant Number Two

belt conveyor, then over a bar grizzly set at an angle of 45 degrees into a 2 M Universal crusher, then by elevator to a Gilbert screen and then the sand is delivered to a Telsmith tank, number five. The belt conveyor has four by eight inch stringers on 25 inch centers and elevates the material $13\frac{1}{2}$ feet to the grizzly. The throughs go under the crusher and there meet the reduced material and with it are lifted by a Stephens Adamson bucket elevator working on 56 foot centers with 10 x 6 inch buckets on 16 inch centers to the washing and screening plant.

This plant has been in operation for three years and has needed revamping to secure uniformity of grade. Sometimes the sand would run too low in percentage of fines, and when an attempt was made to rectify this with the automatic washer the fines were secured but with more silt. In reducing the size of screen openings to get a larger percentage of fines the capacity of the plant was also reduced, throwing a larger percentage of sand over into the pea gravel.

To overcome this problem a double compartment drag washer has been installed, giving a much better product. The fines are now retained, the material is clean and is also delivered with less water, which allows the drawing of material from the bins at any time. With the old automatic sand washer it was necessary to have several bins, allowing one to drain for about two hours before again drawing material from it. The double compartment washer is built with an opening in the division partition, allowing the insertion of a screen in a vertical position, and the opening is opposite the tail pulley, where the most agitation occurs.

The material is delivered at the back of the concrete sand compartment. Near this opening all water must go through a screen to reach the overflow and this action of the water carries whatever amount of fines it is desired to take out of the sand in order that the product may be used as plastering sand.

To overcome the problem of sand storage a belt conveyor, 62 feet long, has been constructed from the top of the sand bin, on a 2 degree pitch. This is driven from the head drive on the washer, with a clutch sprocket, in order that the conveyor may be turned off when not in use. The conveyor is so

Sand Pit Filled by Flood. Material had been taken from this pit to a depth of about 40 feet. Railroad track south of pit was washed out entirely

Conveyor, Crusher and Elevator at Plant No. 1

situated that material can be delivered directly to belt or bin, as desired.

Recently a dry plant has been erected enabling the company to supply material for different classes of work, such as hot asphaltic concrete, used for road making purposes. The moisture in washed material slowed down the production of the asphaltic plant about 10 per cent. One of the noteworthy things about this plant is the neatness of its appearance; the hoist house and sheds are all of corrugated metal and are kept clean and painted. The plant is electrically operated on purchased power. The screen and bucket elevator are run by a 7½ h.p. motor and the crusher and feeder by a 15 h.p. motor.

Wastes in Agricultural Industries

Plans are under way for a study of waste as it affects the agricultural industries, influenced by farm power and farm machinery. The American Society of Agricultural Engineers will have a part in this activity. This will be a study similar in many respects to the study on waste in industry conducted in 1921 by the American Engineering Council. In the announcement this statement is made: "That a given practice is not wasteful until a better one has been revealed. If we are to look at our agricultural industry from this standpoint we can readily realize that there is an enormous amount of waste, much of which can be eliminated by adoption of better engineering practices. The proposed study should bring to our attention not only the wastes that exist but also methods and means whereby they may be largely eliminated."

Road Building in Dominican Republic

The Director of Public Works recently issued a resumé of highway construction in the Dominican Republic since 1908, in which year the Government made the first effort to construct improved highways since the early days of the Spanish colonization period.

This resumé shows that from 1908 to 1916 there were constructed 76 kilometers of highways and work was started on 44 kilometers. The total expenditures during this period amounted to $1,701,348, but as some of the roads were reconstructed at a later date, these expenditures were only in part efficient.

The next period is that of the military occupation by American forces from 1916 to October, 1922, when 314 kilometers were constructed and work begun on 31 kilometers, at a total cost of $5,626,451. During the following period, from October, 1922, to July, 1924, the period of the provisional government, 197 kilometers were constructed and work begun on 50 kilometers, at a cost of $1,531,167. From July, 1924, to January, 1927, or since the installation of constitutional government 206½ kilometers have been constructed and work begun on 97 kilometers, at a cost of $2,787,062. In addition to the above expenditures, the Government has spent nearly $140,000 on surveys and on money grants to assist in the construction of local roads. It is seen, therefore, that during the entire period the Government has spent nearly $12,000,000 on highway construction, the bulk of it since 1918. The cost of repairs and maintenance is not included in the expenditure.

CRUSHERS AND THEIR COMPONENT PARTS

By Wm. T. W. Miller

Part III

PARTS one and two of this series of twelve articles appeared in the July 6th and July 20th numbers, respectively. Mechanisms applied to jaw crushers was the main theme of the first article while in the second article jaws and cheek plates for rock crushers were treated in detail. Mr. Miller begins his third article below and the nine future articles will appear in the ensuing nine issues of PIT AND QUARRY.

Mr. Miller, the author of this series, has had thirty years' experience as a specialist in crushing machinery. For the last twenty-six years he has been employed by Hadfields, Ltd., of Sheffield, England. For the past eighteen years he has been engineer-in-charge of their crushing machinery department. He has studied crushing problems in the United States, Canada, Brazil, Uruguay, Argentine, France, Spain and Portugal.—Editor.

Toggles and Toggle Bearings for Jaw Crushers

Since the days when Eli Whitney Blake invented the first toggle-motion stone crusher the toggle, in some form or other, has been an essential part of the great majority of jaw-type breakers. After the jaws and cheek-plates the toggles must be reckoned among the details which require to be renewed with greatest frequency and excessive wear on these parts has considerable influence on the size of the finished product and on the output from the breaker.

In many instances the adjustment of the swing jaw is made by means of a wedge-block behind the rearmost toggle-plate, but, owing to exigencies of design, the extent of regulation obtainable by such means is usually limited. In Blake-type crushers this adjustment is intended to compensate for wear on the teeth of the jaw-plates as well as in the grooves of the toggle-bearings and on the radiused ends of the toggle-plates. For these purposes the range is frequently entirely inadequate and toggle-plates of varying lengths have therefore to be used.

It is evident that the plates and bearings should be so designed that they may be readily changed when required. They should also be made in the most durable material. With very few exceptions toggle-plates are made with semi-circular or part-circular ends, working in grooves of similar shape, although there has recently been a reintroduction of the earlier form in which the plate may be likened to a slice cut from a roller, the curved ends bedding on flat bearings.

In its simplest form the toggle consists of a flat plate with parallel semicircular ends, as shown in Fig. 1. The plate may be lightened by cored holes through the center which also serve for lifting the toggle into position, or an arched lug may be cast on the upper surface as shown in the figure. It is usual to make the grooves in the toggle-bearing shallower than the semicircle and of slightly greater radius so as to allow for some irregularities and give greater freedom in working.

In actual practice the semicircular end is not the best shape as the wear causes the plate to penetrate further into the groove with the result that, in course of time, there is a tendency for the plate to wedge itself into the deepened recess and the slight radial movement nips the plate on the diagonal edges, causing breakage by bending.

Fig. 2 shows the corrected shape for the plate, which permits a considerable amount of penetration without any sacrifice of freedom of movement. In this figure the plate is shown solid and of suitable proportions for manufacture in cast iron with chilled ends, a lifting iron being introduced to facilitate handling. Some manufacturers prefer to make the toggles the safety valve in the machine and to accomplish this they reduce the section of the plates and core long slot-holes through the castings, as shown in Fig. 3, which illustrates a type of plate particularly suited for manganese steel.

It is always advisable to lubricate the toggle-seatings either by means of grease or oil and, to help to contain the lubricant the plates are frequently made with lips or flange parallel to the hinge edges and set sufficiently far back to be clear of the grooves in the toggle-bearings. The lip is no doubt effective enough at the lower edge of the plate, where the upper angle is less than ninety degrees and the inclination causes the lubricant to run back between the groove and the plate, but, at the upper edge, the slope is all against the return or retention of the lubricant. It is therefore necessary to have some positive system for feeding the oil close to the pressure point either through holes in the toggle-bearings or by means of channels cut into the groove.

Breakages in Blake-type crushers are commonly caused by the introduction of some foreign substance, such as a hammer head, between the jaws, and to safeguard the more vital parts of the machine one of the toggles may be specially constructed to act as a safety device. When made in cast iron the safety toggle may be cambered, as shown on Fig. 5, with a circular hole through the center, which weakens the plate and changes the stress from compression to combined bending.

Fig. 6 shows another form of safety plate made in halves, the sections being riveted together in such a manner that the working stress produces a shearing strain on the rivets and these are proportioned of sufficient strength to sustain the normal crushing pressure and yet give way under any abnormal shock. Solid shearing-plates are sometimes made of the patterns indicated in Figs. 7 and 8, the exact shape and strength of the casting being determined by a series of experiments under working conditions, commencing with a very weak plate and gradually building up the section until it is just sufficient to meet all ordinary loads.

In actual practice these safety plates are rarely so useful as could be desired. The conditions under which a stone crusher works are exceptionally severe: the load fluctuates over a wide range, and fatigue enters very largely into the life of the working parts. For instance, if the rivets joining the two portions of the plate shown in Fig. 6 are made too small in diameter, the bearing area may prove inadequate to resist the constant changes of pressure and, the rivet-holes becoming oval, the joint works loose before the rivets fail. Again, with solid shearing plates, fatigue may set up crystallization of the material with the result that the plates give way without any abnormal strain and become a nuisance rather than a safeguard.

In any crusher it is difficult to maintain absolute parallelism or true alignment throughout the toggle system and the plates have a tendency to travel sideways, especially where the grooves in the bearings have open ends. In extreme cases the plates will rub against the sides and eventually cut holes in the frame of the breaker. To avoid this trouble it is usual to close the grooves in the toggle-cushions or provide other means for centering the plates. Fig. 9 shows a toggle made with a projecting flange in the center of each bearing edge which engages with a semicircular channel cut in the toggle-bearing and so prevents the plate from moving sideways. In Fig. 10, two outside flanges are shown in place of the centerpiece.

As stated at the commencement of this article, it is customary to compensate for wear on the jaws, toggles, and toggle-bearings by means of the wedge adjustment and, when this proves inadequate, by introducing longer toggles.

The question of extensible toggle-plates is one that has attracted inventors for some considerable time, and Fig. 11 illustrates one of the early attempts to solve the problem. This is really a combination of an adjustable and shearing toggle. The plate is made in two overlapping sections which are bolted together, the upper section having slot-holes for the bolts and the lower a projecting lug against which the upper plate bears through the medium of removable packings or shims.

The overall length of the plate may be varied by adding or removing packing strips and if the strain becomes excessive the lug would be sheared off. In a later variation of this type of plate, shown in Fig. 12, the packings are laid in a channel formed in one of the castings and are therefore less liable to fall out. In this case the plate is not designed as a safety toggle and the distance-pieces and toggle ends are arranged in the direct line of the thrust.

Assuming that the toggle is strong enough to withstand the repeated changes of stress, its life will largely depend on the durability of its working edges and it frequently happens that the body is in perfectly sound condition when the plate has to be removed because it has shortened under wear to an extent which renders it unserviceable.

It is natural therefore that efforts should have been made to provide renewable wearing edges by means of which the length could be restored without sacrificing the body of the plate. The construction shown in Fig. 13 has this object in view, but the parts are somewhat difficult to fit accurately together and unless the ends bed properly they are liable to become loose under work.

The toggles used in large sledging breakers attain considerable size and weight and, as they have to be discarded when only a small proportion of the metal has been worn away, the design shown in Fig. 14 should offer several advantages. It this pattern the toggle consists of three parts, a body-casting and two renewable end-pieces which are tongued into the flanges on the body portion and secured by bolts. If the end-pieces become worn they can be renewed without scrapping the center-plate and, if it is desired to shorten or lengthen the toggle, this can be done by changing the width of one or both of the end-pieces.

It is necessary to bear in mind that although theoretically the toggles are subjected to no stresses other than pure compression, yet in practice, due to the friction of the joints and the rise and fall of the pitman, there is a decided bending action which must be taken into account when designing any composite toggle-plate. Gray's patent toggle, shown in Fig. 15, is another type of compound plate which is capable of being expanded or contracted by changing the distance-piece separating the two end sections. The matching faces of the toggle-ends and spreaders are machined to dovetail shape and the latter are fitted with dowel-pegs to prevent end movement. The component parts are drawn tightly together by means of a central right-and-left handed screw, the hexagon head being situated in a recess between two spreaders.

It is doubtful whether the extra cost of these composite plates is warranted in any but the larger sizes. Where the plant is situated close to the source of supply and the plates are small and easy to manufacture it is better to avoid additional complications and adhere to the simpler type.

Should the mine be difficult of access with high freight rates, the whole aspect of the matter is changed and the composite design must receive careful consideration. Toggle-plates for the smaller machines are very commonly made either in white iron or in an ordinary cast iron with chilled ends.

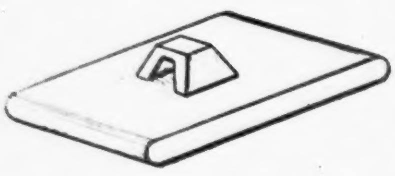


Fig. 1

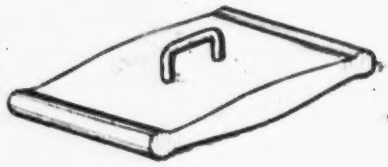


Fig. 2.

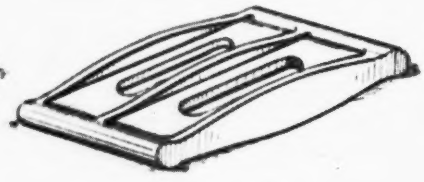


Fig. 3.


Fig. 4.


Fig. 5.

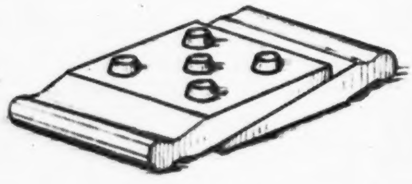


Fig. 6.

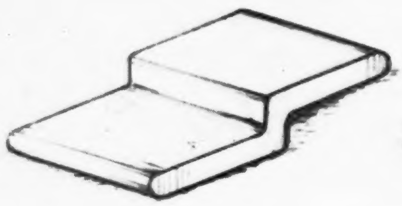


Fig. 7.

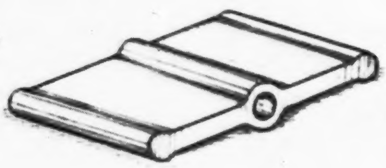


Fig. 8.

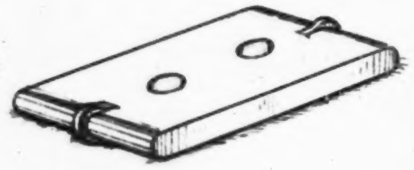


Fig. 9.

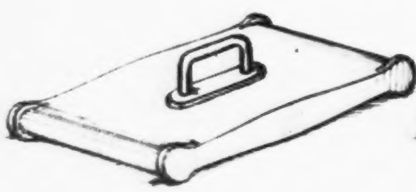


Fig. 10.

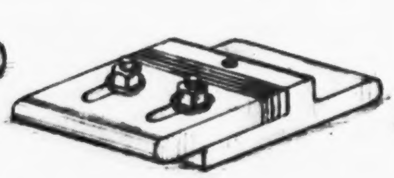


Fig. 11.

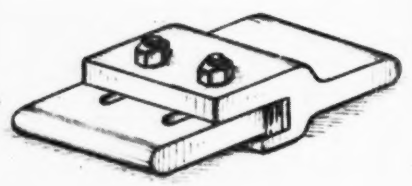


Fig. 12.

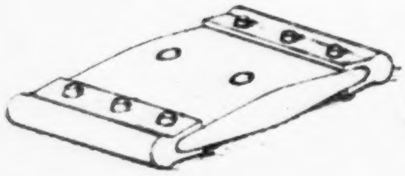


Fig. 13.

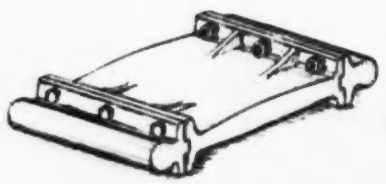


Fig. 14.

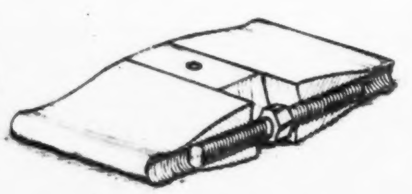


Fig. 15.

In larger sizes a good grade of carbon steel permits of the ends being machined to shape and ensures exact parallelism of the working edges. Manganese steel will give good life but is not easy to machine and any finishing necessary must be done by grinding.

Renewable toggle-bearings are an essential feature of the great majority of jaw crushers and, although they may appear to be relatively unimportant parts of the mechanism, the efficiency of the machine depends on the whole of its working details being kept in good condition. Equally with the toggle-plates the bearings vary in shape, design, and method of fitting and certain types possess distinct advantages as will be explained later.

The simplest form of toggle-bearing is that shown in Fig. 16. It consists of a casting with plain parallel sides, the base being wider than the front face, which has a shallow groove extending the full length.

Bearings of this pattern may be fitted in various ways. The cushion recess may be made of sufficient width to allow the seating to be laid in position, after which the clearance space on the non-pressure side is filled with a packing strip or short wedges. Some makers secure the bearings by means of set-screws acting on the side of the casting which is not under thrust from the downward or upward inclination of the toggles. This system is illustrated in Fig. 17, which shows the lower part of a pitman with the toggle-bearings in place.

In the arrangement shown in Fig. 18, the toggle-bearing is made of the same dovetail section but shallow recesses or grooves are cut across the fitting edges which coincide with key-slots in the containing casting and the wedge-blocks are pressed home by bolts or set-screws. By these means the bearings are locked against end-movement and the wedge fitting gives greater contact area than can be obtained from set-screws.

Some crushing machinery manufacturers make the bearings of plain rectangular section with a centering lug on one side to prevent end-movement, as shown in Fig. 19. In this case the castings entirely fill the cavities in jawstock, pitman, and toggle block, and they are usually ground to pass a template to ensure interchangeability. It is always advisable, when the bearing fills the recess in this manner, to provide wedging slots in the seating or other means to assist in the extraction of a worn cushion as the castings have a tendency to expand and tighten under the pressure of the toggles.

With the same type of bearing the centering lug may be placed on the back as shown in Fig. 20, but, although this has the advantage of making the casting reversible, the fitting edges of the lug are not visible when the bearing is being fixed in position and it is not possible to judge the accuracy of the fit. As pointed out, when describing the various types of toggle-plates, the ends of the grooves in the bearings should be walled-up to prevent the plates from traveling sideways. Fig. 21 shows one method of carrying this out but it is rarely necessary to continue the walls above the level of the remainder of the casting.

In some instances the bearings are secured from side movement by means of cover-plates as shown in Fig. 22, and these plates also serve to seal the ends of the groove and confine the toggle-plates. This construction leaves a clear groove in the bearing, which is an advantage in the event of a machine finish being required. Fig. 23 shows walled-end bearings with a special device for retaining them sideways. A locking plate fits in a groove in the back at either end of the bearings and the projecting ends serve a further useful purpose as a means for driving the cushion out of the recess. The toggle-bearing shown in Fig. 24 is designed to work in conjunction with a plate as illustrated in Fig. 9, the deep channel in the middle of the groove acting as a centering device.

Although it is usual, in the higher grade crushers, to machine the recesses in which the toggle bearings are fitted this practice applies more particularly to breakers made in cast steel than to the more primitive machines with cast iron parts. Fig. 25 illustrates a type of toggle-bearing used by a well-known English manufacturer. The diamond-shaped fitting edges hold the bearing against end-movement and the casting is merely a slack fit in a cored recess. It is obvious that the conformation of the bearing is not well suited for machining.

Various attempts have been made to introduce self-aligning toggle-bearings to compensate for irregularities in fitting and unevenness in wear of the component parts of the toggle system. To meet all adverse conditions the bearings should have universal joints which are not easy to apply to pieces subjected to such severe working stresses. Most inventors have therefore been satisfied to confine their efforts to making the grooves self-righting in either the vertical or in the horizontal plane.

Fig. 26 illustrates a bearing in which the back or main bedding surface is curved to the arc of a circle and any undue pressure on one end causes the toggle-seating to move round and bring the whole length of the groove into equal contact. Fig. 27 is an example of a self-adjusting bearing with the pressure-edge curved to a true arc. Clearance is allowed in the recess on the opposite side so that the casting can turn slightly in the vertical plane to compensate for any twist in the toggles due to lack of parallelism of the shafts in the breaker.

Whilst ideas of this kind are no doubt admirable in theory, in practice the difficulties of machining and fitting the more complicated bedding surfaces render them unpopular with crusher mechanics. Simplicity is a cardinal virtue in any crushing machine. It is sometimes useful to be able to vary the angles of the toggles and so modify the crush-

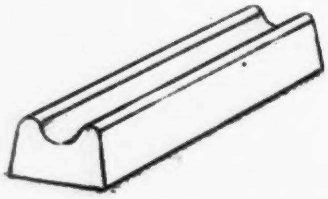


Fig. 16.

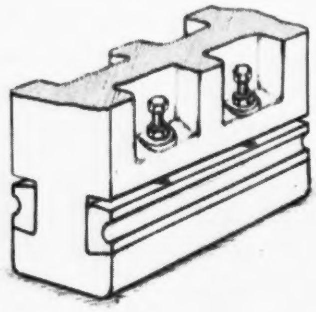


Fig. 17.

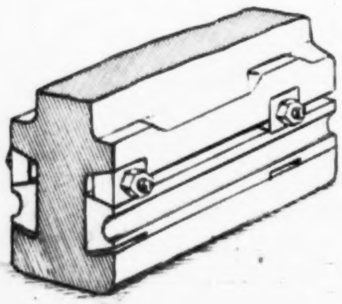


Fig. 18.

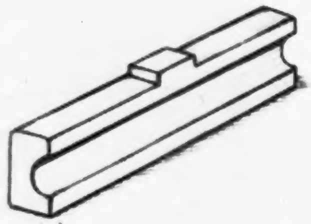


Fig. 19.

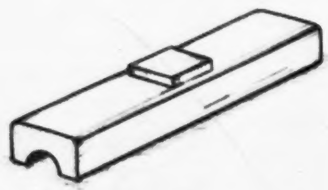


Fig. 20.

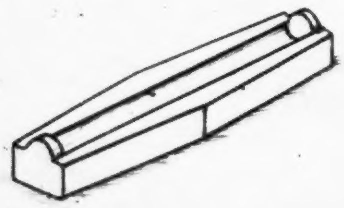


Fig. 21.

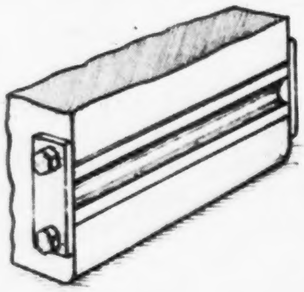


Fig. 22.

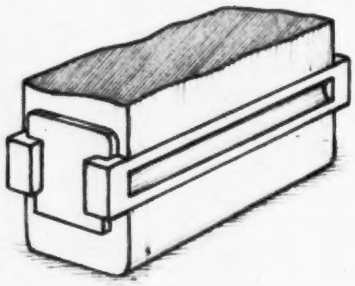


Fig. 23.

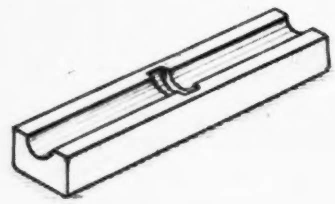


Fig. 24.

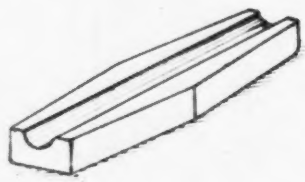


Fig. 25.


Fig. 26.

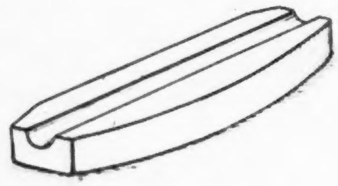


Fig. 27.

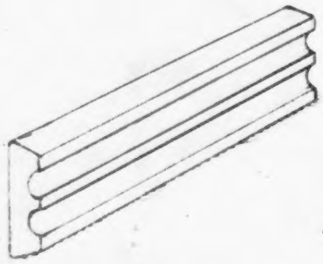


Fig. 28.

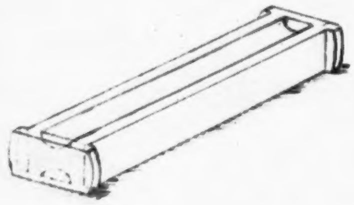


Fig. 29.

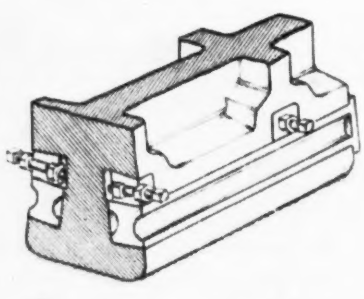


Fig. 30.

ing stroke to some extent without altering the throw of the eccentric shaft. Where the toggle-bearings have a symmetrical exterior this can be done by placing the groove out of center in the bearing so that various included angles may be obtained by changing the relative positions of the grooves in the vertical direction.

Multiple grooves, as shown in Fig. 28, are also used to permit of a quick change in the toggle-combination. Bearings made with double grooves require to be extra wide and, unless the crusher has to deal with material which varies greatly in character, there is little advantage in fitting such cumbersome pieces. Generally speaking the toggle-bearings are worn away until they fail by splitting or cracking along the groove and, if the seating and hinge-end of the plate are properly designed, they can be worn to this extent without impairing the efficiency of the combination.

Some makers advertise reversible bearings with grooves on both sides, as shown in Fig. 29, and occasionally grooves in all four faces of the casting have been suggested, but it is very doubtful whether there is any economy in robbing the bedding surfaces to gain this end. It is really surprising how the intensity of the pressure from the crushing-strokes causes the under-surfaces of the bearings to beat into the bedding faces in the jaw-stock, pitman and toggle-block. In order to identify the pieces the founders are in the habit of casting on the backs of the bearings, in sunk letters, their trade mark and serial number. In many instances a corresponding projection is formed on the machined surface of the container to match the slight cavity, and trouble is bound to ensue when replaced parts do not register exactly with those which have been used peviously.

Fig. 30 will serve to show the way in which the bedding surface, which should be ample and unbroken, is reduced by the use of the reversible toggle-bearings. Although in the early days the renewable toggle bearings were made in cast iron, they are now almost invariably made in steel and frequently in the higher-grade alloy steels. Where it is desired to machine the parts chrome steel will be found to give good wearing properties and manganese steel is adopted by several of the leading manufacturers.

When the crushers are used for exceptionally hard work it will sometimes be found advantageous to use different materials for the bearings and the plates. Manganese steel plates working in grooves of the same composition have a tendency to flow or corrugate on the wearing edges. The action is a peculiar one and the cause not easy to discover. Probably the essential ductility of the alloy may be at the root of the trouble. Just as, in the case of the worm and worm-wheel, it is found advisable to use materials of different composition and hardness, so in the toggle system the application of the same principle will be found to reduce the friction under heavy load.

Metal Lath Conference

The producers of metal lath met at the Department of Commerce on June 17, in an annual revision conference. A committee was appointed to investigate the standardization of weights of the 3/4 rib lath with a view of reaching unanimity on 3 varieties. Certain varieties in the flat expanded metal lath, the 3/8 rib expanded lath and the flat rib expanded lath were adopted as standard with others noted as specials. It was the unanimous opinion of the conference that the industry should make every effort to eliminate these "specials" during the ensuing year. An additional variety, 2.50, was added to the painted 3/8 rib expanded lath. The conference reaffirmed the recommendations of previous conferences for painted steel sheet lath to weigh not less than 4.5 pounds per square yard, with corresponding minimum weights in this type of lath made from special metals or from sheets galvanized before fabrication. Metal lath in all types and weights galvanized after fabrication is to be eliminated, and all types of lath are to be specified and sold by weight per square yard. The provisions of the revision of the recommendation became effective July 1, 1927.

Swedish Commission Reports on Roads

A commission, which has spent six months in Germany, Holland, and England for the purpose of studying road building in these countries, has submitted a report giving the results of its investigations, of which a summary is given below:

A pavement consisting of layers of bitumen and fine macadam is specially recommended for country roads where the traffic is small, as this will follow the contour of the road and not break up the original surface. The cost is said to be only 2.50 crowns to 3.50 crowns per square meter. The use of the most expensive kind of pavement (at 8.50 to 11 crowns per square meter) is not recommended, the commission considering that stone should be used instead in order to help the Swedish stone industry. The medium-priced paving material (at 6 to 8 crowns per square meter) would, however, be suitable for highways with congested traffic. Furthermore, the use of paving stone in steep inclines (more than 1:30) and in sharp turns (radius less than 200 meters) is recommended to minimize the risk of skidding.

Concrete is considered too expensive in comparison with other paving materials for use in Sweden, and is recommended only for cases where the bearing capacity of the road is small, such as in marshy districts. The commission finally states that it has not discovered any method of paving that is decidedly superior to others.

INTIMATE NEWS OF MEN AND PLANTS

Pacific Portland Cement Expands Facilities

From Redwood City, California, comes the report that the Pacific Portland Cement Company recently made the largest shipment in its history, loading two large steamers at the plant's wharf at one time with a combined cargo of 15,000 barrels, or 60,000 sacks. The cement is destined for points along the Pacific Coast. The company, besides shipping its product by rail, is using the local harbor almost daily for shipment by water.

Work is being rushed on the second unit of the plant and, according to Harold Power, manager, it will soon be in operation. This will increase the capacity of the plant from 2,700 to 6,000 barrels a day.

In order to meet the demand for their cement it has been found necessary by the company to add a second giant suction dredge to the plant. The dredge "Texas" has been secured and will work with the "Golden Gate," which has heretofore supplied the plant with material, the source of which, 30,000 acres of tideland, seems inexhaustible. Sea shells and pure clay silt are used in the manufacture of the company's product. There are said to be only two other plants in the world, one in Texas, and one in India, using similar methods in manufacturing cement.

Protest City Gravel Project

The Builders' Exchange of Los Angeles, California, have filed a written protest with the Board of Public Works against a proposal for the city to buy gravel-bearing lands and erect a plant in the San Gabriel river wash, near Azusa, at an approximate cost of $650,000.

In a letter accompanying the resolutions the exchange says that it is not raising the question of the principle of municipal ownership of public utilities. "Even the most ardent advocate of municipal ownership will hesitate to indorse the spending of taxpayers' money in an uncertain and hazardous adventure in an untried field of private enterprise in which the city would be in competition with those whose lifetime of training and whose entire capital has been invested in devising every modern method for the economic production, handling and transportation of their product under intense competitive conditions," the letter states.

It also points out that the city has been paying 75 cents to 90 cents a ton for its rock and gravel and one job was bought for 50 cents a ton. "Assuming the proposed speculative venture should pay for itself in ten years, it will be seen that the financial burden on every ton produced by the city, even if run continuously at the proposed capacity of 1,200 tons a month, would be 45 cents a ton, without any labor or other productive cost whatever," the letter states.

It is also argued that the city will have to grant a right of way for flood control purposes over the proposed gravel bed site, which would detract further from possible profit.

New Gypsum Plant for Washington

According to a report from Bellingham, Washington, sites there for the erection of a gypsum converting plant are now being inspected by officials of the syndicate of local and British Columbia men who are developing a mountain of the raw material at Falkland, B. C.

George W. Hammond, of George W. Hammond and Company, of Vancouver and Bellingham, manager of the syndicate, has been inspecting possible sites both in Washington and in British Columbia.

The Washington plant will be located either in Bellingham or Tacoma, it was stated by Mr. Hammond. This will depend upon conditions as to what locations are available, the power and fuel facilities and rates and also the taxes, etc. The British Columbia plant location has narrowed down to Kamloops or Chilliwax. The plants will be of 200-ton capacity each, it is said. Cement plants are expected to want about 100 tons daily, making the total shipments from Falkland 500 tons daily.

Robert Wilkinson, who has inspected the deposit, estimated hundreds of thousands of tons ready to trap into chutes leading to bunkers, where the material can be dumped into trucks to haul to the railway. It looked to Wilkinson as if much of the mountain had fallen down, shattering the gypsum into the right sizes to ship, and it can be put to tidewater as far south as Portland at a less price than any other known deposit. H. R. Budd, manager of the London and British North American Company, Ltd., of Vancouver, is trustee for the syndicate, it was announced.

Valuable Deposits of Asphalt Found in Missouri

It is reported from Jefferson City, Missouri, that valuable deposits of natural asphalt containing the proper amount of silica for road building have been discovered in Vernon county by Eastern interests. The deposits are located nine miles west of Nevada, the county seat. Tests indicate the material equals the celebrated "ky-rock" of the Kentucky asphaltum deposits.

It is believed that the Vernon county deposit may prove of value in Missouri's road building program. A committee from the state highway department, including Carl W. Brown, assistant chief engineer; J. R. Davis, of Nevada, and E. J. McGrew, of Lexington, a member of the highway commission, will investigate the possibilities of the deposits with a view of determining its practicability in solving some of the problems confronting road builders in Missouri.

U. S. Silica Company Expands

According to a report from Ottawa, Illinois, construction of the new addition to the plant of the United States Silica Company, which will practically double the capacity of the company's plant, is well under way. The new plant, which is to cost about $175,000, will be one of the largest sand washing and drying units in that section. The building is to be 170 feet in length, 52 feet wide, and will stand 65 feet high. A corps of workmen are now busy on the new structure, rushing it to an early completion so that it can be finished in September.

The building is the largest industrial construction job of the year in the vicinity of Ottawa. The Allen & Garcia company of Chicago are the engineers in charge, and the Warden Allen Construction Company of Chicago have the building contract.

Florida Cement Appoints

The Florida Portland Cement Company, Tampa, Florida, announces the appointment of Frank M. Traynor as director of sales.

Pyrophyllite Mining in N. C. Increasing in Volume

The North Carolina Department of Conservation reports that developments at the two principal scenes of pyrophyllite mining in North Carolina are making way for a larger volume of output from what mineralogists declare to be the only commercial deposits in the United States.

The Standard Mineral Company at Hemp has been taken over by the R. T. Vanderbilt Company, which plans a greatly enlarged output.

New machinery is being installed at the plant of the United Talc and Crayon Company at Glendon, and operations of the plant in turning out powdered materials has started. The first carload shipment since the company has come under new ownership was made recently from Glendon and the management expects to maintain a good rate of operations. The new machines will furnish a maximum of 40 tons of powdered pyrophyllite daily for the paper and rubber trades, and machinery to be installed soon will have a capacity of between 10 and 20 tons daily for the roofing trade.

Besides the pulverized materials, the company is marketing a large number of pencils. The daily capacity of these machines is 200 gross.

Ash Grove to Build Another Cement Plant

The Ash Grove Lime and Portland Cement Company, whose general offices are at Kansas City and which operates a large cement plant at Chanute, Kansas, and lime plants at Ash Grove, Kansas, and Galloway, Missouri, announces that it will build a large new cement plant at Louisville, Nebraska, to cost $2,000,000 and eventually to have a capacity of 1,500,000 barrels a year. A residence district will be developed at Louisville for the 200 employees of the company there. This will be on a wooded tract overlooking the Platte river near the plant and will be provided with a water and sewage system. L. T. Sutherland, of Kansas City, has been president of the company since 1909.

D. S. MacBride Promoted

Announcement is made by the Indiana Portland Cement Company, Indianapolis, a subsidiary of the International Cement Corporation, that D. S. MacBride, manager of the company, has been appointed vice-president and manager. Mr. MacBride has been associated with the corporation for a number of years, coming to Indianapolis two years ago when the Indiana company was merged with the International Corporation.

Oklahoma Portland Cement Buys Arkansas Railroad

According to a report from Ashdown, Arkansas, the purchase was announced there recently of 50 per cent of the common and preferred stock of the Graysonia, Nashville and Ashdown Railroad by the Oklahoma Portland Cement Company, of Ada, Oklahoma, the purchase price approximating $500,000. This was taken to mean that a $3,500,000 cement manufacturing plant, which had been planned for some time, will soon be built near Ashdown.

The railroad is a part of the old Memphis, Dallas and Gulf railroad, and runs between Nashville, where it connects with the Missouri Pacific Railroad, and Ashdown. At this point it connects with the Frisco system. The line runs directly through the immense chalk deposits near White Cliffs, where large holdings have been bought recently by the Oklahoma Portland Cement Company.

The cement plant, which will be of 1,500 barrels capacity per day, will be built at White Cliffs. The cost of the plant itself will be close to $3,000,000, it was stated by a member of the firm known to have been interested in securing further holdings of the land under which the chalk deposits are located.

The construction of additional facilities to the plant, and the expenditures which will be made by several public utilities companies, will bring the total expenditures in and about White Cliffs to more than $5,000,000, it was stated.

Harry A. Keener Passes

Harry A. Keener, president of the Keener Sand and Clay Company at Columbus, Ohio, died unexpectedly on July 19, at his suburban home. Mr. Keener, who conducted the Sand and Clay Company's business for the past 20 years, had been in poor health since suffering a stroke last October and had just returned from a week's visit in Northern Indiana. He is survived by his widow, two daughters and a brother.

Mr. Keener was born at Constantine, Michigan, 57 years ago and came to Columbus from Chicago. He was a member of Kinsman Lodge of Masons, Scioto Consistory of the Scottish Rite, Aladdin Temple of Shriners and the Rotary Club.

Cleveland Concerns Merged

The merger is announced of the local interests of the Standard Slag Company in Cleveland with the Goff-Kirby Coal Company, operating 10 coal and supply yards in that city. Between $750,000 and $1,000,000 is represented by the union of these interests in Cleveland. The business will be conducted under the name of the Goff-Kirby Company. The combination was effected for the more economical operations of the affected businesses. It will give the Standard Slag interests increased outlet for their cement products.

In announcing the transaction a Cleveland paper points to the exceptional progress of L. A. Beeghly, president of the Standard Slag Company, since he quit the management of a crushed stone company in Toledo in 1914 to organize the Standard Slag Company.

To Open Kaolin Deposits

From Chewelah, Washington, comes the report that another attempt is being made to open the kaolin, ochre and sienna deposits in the south end of Stevens County, north of Deer Park. A new company has been formed and articles of incorporation were granted. The first work will be on the kaolin and later on the ochre and sienna. Officers of the company are: President, Aimon Baker, Deer Park; vice president, Dr. John W. Lande, Goldendale; secretary-treasurer, W. C. Trowbridge, Goldendale; color expert and general manager, W. J. Harper, Danville, Cal.; sales manager, M. G. Swanson, Deer Park.

U. S. Gypsum Buys Land in Colorado

The mill of the United States Gypsum Company at Loveland, Colorado, is one of the oldest industrial plants in that section, and is steadily expanding to meet the increased demands on it from Oregon and Washington as well as from its immediately surrounding territory.

In order to be prepared for the future development of their business the company has been acquiring more gypsum land from time to time, and just recently, it is reported, all the gypsum-bearing lands owned by Alfred Wild have passed into its hands. Last year the land owned by Bud Ragan was bought. These purchases of high priced land show that the company is using keen foresight in fortifying itself with ample raw material to last a great many years.

New Arkansas Cement Plant Will Soon Break Ground

According to a report from Batesville, Arkansas, the Missouri Portland Cement Company will soon begin the construction of a plant near that city. The projected movement has been contemplated for some time, but has been hanging fire because of difficulty in obtaining a satisfactory agreement for power facilities, it was said.

Information as to the deposits of Boone limestone and Moorefield shale, which will be used in the manufacture of a "quickset" cement, was furnished representatives of the Missouri company by E. E. Bonewitz, engineer, of the firm of William Crooks & Co. Mr. Bonewitz has been engaged in surveying the proposed site for several weeks.

The capacity of the plant will be approximately 500 barrels of cement per day. Material to be used in its manufacture will be limestone and shale in huge quantities, and in addition gypsum and bauxite. The bauxite will be purchased from the American Bauxite Company at Bauxite.

The strata of limestone and shale converge at a point about seven miles north of Batesville, near the tracks of the Missouri Pacific railroad. The plant will be located near this point, which is considered by engineers to be an ideal location. It was discovered by Mr. Bonewitz several years ago. When the Missouri Portland Cement Company officials became interested in locating a plant near Batesville he was engaged to furnish a survey and reports.

Model Ohio Crushing Plant Goes Into Production

A report from Marion, Ohio, is to the effect that the Ohio Blue Limestone Company, operating a quarry three and a half miles from that city, have finished the installation of their new $150,000 equipment. To complete the changes made in the plant required over a year's time, during which the quarry practically suspended operations. Present plans are to maintain an output of between 2,000 and 3,000 tons daily. In a test made shortly after completing the installation five and a half tons of stone were crushed in 20 seconds.

The new plant is a model in all its details, and there are few others of its type in the country. The company is provided with excellent railway and general transportation to handle its output.

Ohio Company Acquires Rich Gravel Deposit

A deal is reported from Chillicothe, Ohio, whereby the East End Sand and Gravel Company, under the management of Don M. Poston and E. F. Bearce, bought sixteen acres of land lying along the Scioto river. The land comprises one of the most valuable deposits in that section, being free from muck and deteriorating mixtures, and most of it being large gravel suitable for road building and concrete.

The East End Sand and Gravel Company will run a spur track over to the B. & O. railroad and will thus have outlet for its products direct to shipping agencies or customers. The deal just made contemplates a development which will run close to $200,000 and will call for the installation of a large suction dredge, washer and other machinery.

U. S. Gypsum Plans to Build Philadelphia Plant

According to a report from Philadelphia, work will soon begin there on another link in the eastern chain of manufactories and warehouses of the United States Gypsum Company, a site of seven acres having been purchased at Fifty-eighth street on the Schuylkill river.

The first unit to be erected will be a 60x200 warehouse, plans and specifications for which already have been completed. Adjacent to this will be erected a mill for the calcining of gypsum rock into plaster and the manufacture of a full line of gypsum building materials.

The raw gypsum rock required will be brought by water from the company's quarries in Nova Scotia and will be unloaded directly from the ships to the mill. From the plant it will be possible to lighter finished gypsum products to points on the Schuylkill and Delaware rivers and Chesapeake bay. Shipments also can be made in any direction by rail and truck.

Signal Mountain Portland Changes Sales Unit

Recent changes in the sales organization of the Signal Mountain Portland Cement Company at Chattanooga, Tennessee, include the appointment of Frank Conkling as director of sales, Irving Sisson as assistant sales manager and J. Dan Bowden as special representative.

Unusual Granite Deposits Revealed in Minnesota

Granite deposits of an unusually high quality, it is reported, have been discovered by Henry E. Winchester, a granite expert of St. Cloud, on a 120 acre stretch north of Chisholm, Minnesota. Other experts, including a former employe of the Cold Spring Granite Company, of Cold Spring, near St. Cloud, who have studied the deposits, aver that the granite is of a texture and fineness equal to the "Rock of Ages" granite of the Barre, Vermont, region.

McCall Heads Soils Work for New Bureau

Prof. A. G. McCall, of the University of Maryland, who is well known to the lime industry, has been selected to head the soils work of the new Bureau of Chemistry and Soils of the Department of Agriculture. He will take the place of Prof. Milton Whitney, who has headed this work since its organization in the department, but who is now obliged, on account of ill health, to relinquish exacting administrative duties.

New Tennessee Cement Plant Plans Construction Work

It is reported from Knoxville, Tennessee, that work is to begin at once on construction of the million-dollar new Volunteer Portland cement plant. Contracts have been awarded to the Burrell Company, Chicago, and the Virginia Bridge Company, Richmond. The new plant will be located on the eastern outskirts of the city. It will be completed in time for operations next spring. Three thousand barrels of high quality cement will be produced daily.

Cement Company Expands

The Sandusky Cement Company, York, Pennsylvania, it is reported, has begun the erection of a unit for the manufacture of gray cement as an addition to the company's white cement plant in West York. It is expected to complete the new unit in about eight months.

Louisiana Portland Appoints

Louis R. Ferguson has been appointed vice-president and general manager of the Louisiana Portland Cement Company of New Orleans. Ben F. White has been appointed sales manager.

New Incorporations

National Mortar & Supply Co., 614 Wrigley Bldg., Chicago, Ill. $6,463. Pennsylvania corp.

Lime Rock Asphalt Co., Memphis, Tenn. Texas agent, B. Y. Sharp, Uvalde, Tex.

Standard Sand & Gravel Co., Lewis Marshall, Augusta, Ga. $35,000. John D. Twiggs. Plant to be located at Blun, Ga.

Superior Gravel Co., Houston, Tex. W. M. Donnelly, W. K. McCardell, 1510 Ridgewood St.; Frank J. Schleuter, 3617 Main St. $10,000.

Succasunna Sand & Gravel Corp., Succasunna, N. J. Henry Blum, J. H. Schiller, Helen Marsak, New York. Attorney, H. Ely Goldsmith, New York.

Columbia Digger Sand & Gravel Co., Portland, Ore. E. E. Crout, W. W. Taylor, O. F. Barsian. $10,000. Filed by Raffety & Pickett, Title & Trust Bldg., Portland.

Portland Crushed Rock Co., Portland, Ore. 4000 shares. Chas. M. Drummond, Pres.; M. A. Peck, Treas.; Wadleigh B. Drummond.

Carl Furst Co., Bedford, Ind. $150,000. Carl Furst, Philip C. Furst, Glen C. Frank. To quarry stone.

Sare-Hoadley Stone Co., Bloomington, Ind. $150,000. John W. Hoadley, Thomas J. Sare, Albert Hoadley.

South Jersey Silica Sand Co., Bridgeton, N. J. Douglas V. Aitken.

Perry Sand & Supply Co., Earlville, Kent P. O., Ohio. $500. Perry E. Masek, L. A. Masek, Elmer T. Johnson, Frank Rose, Frank McConn.

Mid-Island Sand & Gravel Corp. Harry Grasser, Long Beach, L. I., N. Y. 5000 shares.

Webster Gravel Co., Inc., Minden, La. $12,000. W. T. Drew, W. P. Devereaux, R. E. Lee.

Vermarco Lime Installs Fire Alarm System

The Vermarco Lime Company have installed a fire alarm system, including siren and automatic coding device manufactured by the Federal Electric Company.

Adirondack Feldspar Secures Two New Properties

Two new feldspar properties were acquired recently by the Adirondack Feldspar Corporation. These properties are at Gilsum, New Hampshire. Work was begun on one of them July 26. The feldspar is of a high grade potash spar and the Adirondack Feldspar Corporation expects to produce 50 tons per day, beginning about September 10.

Recent Patents

The following patents of interest to readers of this journal recently were issued from the United States Patent Office. Copies thereof may be obtained from R. E. Burnham, patent and trade-mark attorney, Continental Trust Building, Washington, D. C., at the rate of 20c each. State number of patent and name of inventor when ordering.

1,631,971. Liner for tube mills, etc. Povl T. Lindhard, Brooklyn, N. Y., assignor to F. L. Smidth & Co., New York, N. Y.

1,631,972. Liner for tube mills. Povl T. Lindhard, Brooklyn, N. Y., assignor to F. L. Smidth & Co., New York, N. Y.

1,632,124. Ore-crusher. Theodore Freiberg, Prescott, Ariz.

1,632,739. Coal screen and washer. William F. Martin, Harrisburg, Pa.

1,632,746. Apparatus for cutting and mixing sand. Verne E. Minich, New York, N. Y., assignor to American Foundry Equipment Co., same place.

1,632,755. Means for fastening hoisting rope to skip-buckets and counter-weights. Herbert E. Birch, Philadelphia, Pa., assignor to R. H. Beaumont Co., same place.

1,632,810. Mining-machine. Frederick W. Young, Wilmette, Ill., assignor to Goodman Mfg. Co., Chicago, Ill.

1,632,990. Mining machine. George Bodin, Chicago, Ill., assignor to Goodman Mfg. Co., same place.

1,633,132. Process for preparing a material for the manufacture of artificial stone or rock products. Robert Schoenhoefer, Brunswick, Germany.

1,633,305. Grab. Dudley J. Barnard, Barking, England.

1,633,682. Concrete-mixer. Karl R. Schuster, Hopatcong, N. J.

1,633,790. Cement composition. Robert S. Lindstrom, Chicago, Ill.

1,634,231. Construction of concrete piles or columns. Alfred Hiley, Rickmansworth, England.

1,634,255. Method and apparatus for handling cement and bulk material. Wilfred H. Drath, Butler, Pa.

1,634,385. Sand-separator. Axel G. J. Rapp, Chicago, Ill.

1,634,424. Method of producing improved lime hydrate. William K. Hunter, Knoxville, Tenn.

1,634,505. Oxychloride cement and process of making same. William J. McCaughey, Columbus, Ohio.

1,635,212. Lime-sludge product (building-blocks) and process of making the same. Clarence J. Herrly, Pittsburgh, Pa., assignor to Prest-O-Lite Co.

1,635,276. Chain rail-car conveyor. George M. Johnson, Jeanette, Pa., assignor to Fort Pitt Mine Equipment Co., same place.

1,635,434. Power-shovel. John D. Rauch, Lima, Ohio, assignor to Ohio Steam Shovel Co., same place.

1,635,453. Centrifugal impact pulverizer. Francis E. Agnew, Huntington Park, Cal.

1,635,488. Mining-machine. Jacob M. London, Tunnelton, Pa., assignor to Sullivan Machinery Co., Claremont, N. H.

1,635,623. Mining apparatus. Morris P. Holmes, Claremont, N. H., assignor to Sullivan Machinery Co.

Superior Cement Company Incorporates

According to a report from Jackson, Ohio, the Superior Cement Company, at Superior, Ohio, which has been operated in the past by the Wellston Iron Furnace Company, has been incorporated as a distinct organization, with principal offices at Jackson. The Superior cement plant is a flourishing business, which has grown rapidly under the management of Mr. S. E. Stephenson, president.

New Recording Ammeter Catalog Issued

A new section to Catalog 1502 has been issued by the Bristol Company, describing the latest developments in recording ammeters, together with price list. The section illustrates different types of recording ammeters using strip charts and round charts with various methods of recording continuously.

An example of the kind of data these records furnish is illustrated by a recording ammeter connected in series with a crusher operation. The ammeter, by recording the load of the individual motor, at all times shows the superintendent the exact running time of the crushers, even at night when he is not around; gives actual and definite data on the cost of production and enables the superintendent to determine which crushing operations are using or wasting power. In one case the Bristol recorder showed that a certain operation required a 16 h.p. motor when a 10 h.p. motor was previously deemed sufficient.

The method of making records on charts is a feature of importance in adapting the recording instrument to the work in hand and the new section of the Bristol Catalog illustrates and describes these methods in detail.

The greatest number of Bristol's recording ammeters now in use are equipped with the short coil, attractive disc type of movement, which is recognized for sturdiness and accuracy under long continuous service, and high torque.

NEWS OF EQUIPMENT MANUFACTURERS

P & H Excavators for Cuba

Eleven P & H excavators of the latest model were recently exported by the Harnischfeger Corporation to Cuba and are now being used on the Central Cuban highway, said to be the longest paved highway ever covered by a single contract. It is 700 miles long, extending almost the full length of the island, through the provinces of Pinar del Rio, Havana, Matanzas, Santa Clara, Camaguey and Santiago. It will be paved with Warrenite Bitulithic, manufactured by Warren Brothers Company, the principal contractors. The estimated cost of this highway is $75,840,000, and Secretary of Public Works Carlos Miguel de Cespedes pledges that it will be completed by 1931.

P & H machines are used exclusively on the job, and many dragline, shovel, clamshell and skimmer scoop attachments were purchased by the contractors to meet every requirement of highway construction work. The Harnischfeger Corporation has also sold four additional P & H excavators to the Cuban Government to be used in carrying out a program of municipal and port improvements.

Morris Overhead Runways Described

Herbert Morris, Incorporated, in Book 106, just issued, describes that concern's well known system of industrial runways and presents illustrations of various interesting installations of their modern industrial track without movable parts, together with a blueprint diagram to help in planning a runway system. It also illustrates the Morris flexible system of switching, with selfsteering, roller-bearing trolleys, as well as the Morris worm-gear chainblock hoists.

Extension for Paint Sprays

A recent successful development to aid in painting and reduce costs is the extension for Milburn sprays, which allows a great saving in time and provides a convenient method for painting ceilings, high walls, ship tanks, freight cars and other high surfaces and eliminates the use of ladders or scaffolding.

The extension is 8 feet long, and this, coupled with the operator's reach, projects the painting operation to an approximate height of 14 feet. Any other length of extension, the makers say, can be furnished on specification. For painting within arm's length, the gun is immediately detachable for use as a hand spray.

A slight pull on the operating handle of the extension operates both the air and the paint valves of the spray gun simultaneously. The paint, under pressure, flows to the atomizing chamber, is expanded and driven with ample force into the pores of the surface to be covered. Daubing and brush marks are eliminated, the atomization being so fine and even that "orange peel" is reduced, minimizing sanding and rubbing.

General Electric Bulletins

The following illustrated bulletins of interest have just been issued by the General Electric Company:

GEA-80A—Describes CR7061 starters, for high and low voltage, with standard capacities as follows: Three phase, 25 cycles, 20 to 450 h.p., 1.0 p.f., 220 volts, and 20 to 500 h.p., 1.0 p.f., 440,550 and 2200 volts. Two phase, 50 and 60 cycles, 20 to 450 h.p., 1.0 p.f., 220 volts, and 20 to 700 h.p., 1.0 p.f., 440,500 and 2200 volts. These automatic starters are the recommended standard starting equipment for medium and high speed synchronous motors, driving pumps, motor generators and general purpose applications. They can be operated by push button, float switch or pressure governor, providing undervoltage or protection, depending on the accessory used.

GEA-579A—Push - and - pull button control switches. These are substantially and compactly constructed, easily operated, and require the minimum amount of panel space. They are designed especially for use on switchboards.

GEA-733—Duplex controllers for a.c. squirrel cage motors, with combined manual and automatic control, overload protection or under-voltage release. The primary resistance types are made enclosed or open, for one or two motors, as are also the full voltage types. These controllers are for use with squirrel-cage induction motors driving house pumps and sump pumps and for such other applications as require continuity of service.

The Waukesha Motor Company, manufacturers of heavy duty Ricardo Head industrial and vehicle engines, have opened their new Eastern sales office at 8 West Fortieth Street, New York City. Their office was formerly in the Aeolian Building, 33 West Forty-second Street.

Power Specialty Combined with Wheeler Condenser

Announcement is made of the consolidation of the Power Specialty Company and the Wheeler Condenser and Engineering Company. These two old established concerns have been pioneers in many new engineering developments and are among the strongest and most highly respected of the manufacturers of auxiliary power plant and oil refinery equipment.

The assets, plants, engineering, research and sales departments and subsidiaries of both companies will now be assembled under one corporate identity to be known as the Foster Wheeler Corporation. The most widely known products of these companies—and they have been installed in every continent in the world—are superheaters, economizers, water cooled furnaces, air heaters, tube stills, unit coal pulverizers, condensers, pumps, cooling towers, feed water heaters, evaporators, fractionating equipment and heat exchangers. These are built at Dansville and Newburgh, N. Y., at Cartaret, N. J., St. Catharines, Ontario, Canada, and at Egham, Surrey, England. The companies have branch offices throughout this country and subsidiaries in Canada and Europe. Thus, the combination of departments will effect valuable economies and the increased plant facilities with greater volume and buying power are certain to result in desirable savings.

The new officers will be those of the old companies, as follows: J. J. Brown, chairman of the board of directors; Pell W. Foster, vice chairman and treasurer; L. B. Nutting, president; John Primrose, vice president; H. S. Brown, vice president; W. E. Dowd, Jr., vice president; David McCulloch, secretary and general manager; W. F. Keenan, Jr., chief engineer.

New Harnischfeger Branch

Harnischfeger Corporation announce the opening of a new branch office at 330 Gateway Bank Building, Minneapolis. This building was formerly known as Temple Court. Mr. P. H. Sackett, district manager, is in charge of the office, and Mr. C. C. Yetter, sales engineer, will assist him in covering the Minneapolis territory. The P & H standard line of traveling cranes, gasoline driven shovels, draglines, clamshell cranes and trenching machinery will be handled by the branch office.

The Bulldog Gyratory

The Traylor Engineering and Manufacturing Company, in a circular just issued descriptive of the Bulldog gyratory crusher, points out several of its distinctive features making for the elimination of operating difficulties. For example, the spider, because it is so firmly seated as to be practically an integral part of the top shell casting, cannot weave and yet is easily removable when required. The shaft is indestructible because: (1) by reason of its large diameter it cannot deflect or break; (2) the self-tightening suspension nut and head nuts prevent the stripping of threads, and (3) because the lower end is provided with a sleeve which takes all wear and which at the same time constitutes a self-aligning feature. Smooth operation is assured by the eccentric, which, because of its length and maximum diameter, provides a minimum unit bearing pressure, and it is driven by machine-cut steel gearing. A positive dust seal secures the absolute exclusion of all foreign matter from the bearings, and an automatic force-feed lubrication system further contributes to the high efficiency of the Bulldog.

New Arrangement for Horizontal Air Compressor

The Pennsylvania Pump & Compressor Company has recently placed on the market a new arrangement for horizontal, double acting air compressors which bids fair to become popular where floor space is limited.

Heretofore, in a belt driven unit, the closest spacing has been by the use of a short belt drive, where the motor is set ahead of the compressor, with an idler riding on top of the belt to provide the necessary tension and take-up.

The drive employed by the Pennsylvania Pump & Compressor Company for these compact units is the multiple belt drive known as "Texrope," manufactured by the Allis-Chalmers Manufacturing Company.

This consists of a number of very flexible V-shaped rubber fabric belts operating in grooved sheaves, very similar to the English or separate rope drive.

The great advantage of this "Texrope" drive is that it permits the use of very short centers, and the absence of slippage due to the "V" shape of the belts.

This eliminates the use of an idler and the motor may therefore be set up immediately ahead of and in the closest proximity to the frame of the compressor, and where space is extremely limited, the motor may be mounted directly on top of the compressor frame.

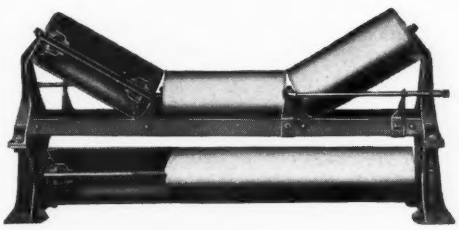
Either method of mounting makes a very neat arrangement, and in the overhead drive, as shown in illustration, it will be seen that no additional floor space is required for the motor.

Inexpensive maintenance, high efficiency, minimum floor space and quiet operation are the characteristics of this drive.

Roll for Conveyors

A new type of conveyor roll is now being placed on the market by the Webster Manufacturing Company. The roll is practically unbreakable, being made entirely of malleable iron and steel. There is no cast iron used in its construction.

The carrier and return rolls are made of 6 inch steel tubing. The



end caps are of malleable iron, fitted in the tubing with edge protruding and extending flush with the outside of the tubing. The cap fits tight, excluding all dust from the bearings. Extra heavy tubing is used and the rolls are turned and balanced.

Edges of the rolls are rounded, and there is a minimum of space between the concentrator and horizontal pulleys. These features protect the belts from wear and eliminate pinching at the bend and add longer life to the belt.

Two Timken roller bearings, of the same type as are used in automobiles, are fitted to each roll. Special adjusting collars easily accessible are provided to take up wear and adjust should occasion require. The lubricating can be done while the conveyor is running, each bearing being fitted with a positive high pressure lubricating system. All fittings are accessible from the outside.

One of the most desirable features is that all parts are easily removed from the frame. The rolls can be lifted out and replaced with ease and there are no screws or bolts used in the assembly.

Before offering it to the trade it was thoroughly tried out in actual service and has proved entirely satisfactory.

Conveyor Data Book Issued

Link-Belt Company has just issued its Conveyor Data Book number 615, a handsome and durably bound volume of 148 pages, which gives in pictures, diagrams, tables and text every detail of various belt conveyor systems, with belts from 16 to 48 inches in width. All the elements and accessories of the belt conveyor are also fully covered, such as anti-friction rolls and idlers, trippers, speed reducers, motors, couplings, shafting, safety collars, head and foot pulleys, etc.

Because of its large capacity, due to its continuous delivery at a relatively high speed, the belt conveyor is admirably adapted to the handling of large quantities of material. Its small consumption of power also makes for a minimum handling cost per ton. Depreciation and maintenance can be kept down by the use of high grade equipment. The principal essentials to economical service—protection of the belts and low power consumption—are controlled largely by the character of the idlers, which are the road bed on which the belt travels, and on their construction the Link-Belt Company has centered particular attention, building into their design the results of years of belt conveyor experience.

McKnight Joins Stearns

Lynn B. McKnight, who for the past eight years was associated with the Dodge Manufacturing Company of Mishawaka, Ind., in various sales capacities, has been appointed sales manager of the Stearns Conveyor Company of Cleveland, manufacturers of Stearns belt conveyors and silo storage systems. Mr. McKnight was with the Dodge company from 1919 to 1921 at their home office and in 1921 was sent to the San Francisco office to take charge of the Pacific Coast. In 1923 he was made sales manager of the Cleveland and Pittsburgh district. Mr. McKnight is a graduate of the School of Mechanical Engineering of Purdue University, 1915.

The Stearns Conveyor Company is owned by Chain Belt Company of Milwaukee.

The Western Wall Board Company and The Schumacher Wall Board Corporation (Seattle Division), manufacturers of plaster wallboard, plaster board lath and gypsum partition blocks and distributors of Hanover hardwall plaster, have consolidated under the name of the Gypsum Products Corporation. The main offices of the company will be at 6851 East Marginal Way, Seattle, Washington.

A New Speed Changer

Stephens-Adamson Company is sending out an illustrated folder describing the J. S. F. variable speed transmission—a new speed changer which receives power at high speeds and delivers the same power at low speeds which may be changed at will. In this machine the ingenious application of a new principle has produced a variable speed changing device which operates quietly, efficiently and without vibration—a device in which roller bearings act in the new role of transmitting power. The actual transmission of power is accomplished through the resulting action of genuine roller bearings revolving in polished races, submerged in oil. A small hand wheel controls the speed of the slow shaft. The reducer is fully enclosed, quiet in operation, and guaranteed to be over 95 per cent efficient. It is made in four standard sizes to transmit from ½ to 15 horsepower at the maximum of reduction and will provide a range of speed variation of about 5 to 1.

Wait Type Steam Turbines Described in Detail

Dean Hill Pump Company, in bulletin 1202, just issued, describes and illustrates the Wait type of steam turbines, designed to meet the requirements of modern plants using high pressure and temperature steam. The steam, after expanding in the nozzles, passes through the single row of wheel blades for its first impact. It then enters the return guides, where its flow is directed back onto the blades for a second impact, thereby using all the remaining energy in the steam. Thus, instead of admitting the high pressure steam into the casing, necessitating complicated casing designs to eliminate the resulting expansion, the Dean Hill design keeps the high pressure steam entirely out of the casing, making it unnecessary to use cast steel casing and centerline supports. The only parts of the turbine which come in contact with the high pressure steam are the throttle valve, throttle valve body, emergency butterfly valve, nozzle and nozzle stand. These parts are of cast steel or monel for high pressure and temperature steam.

Waukesha Motor Opens New Eastern Office

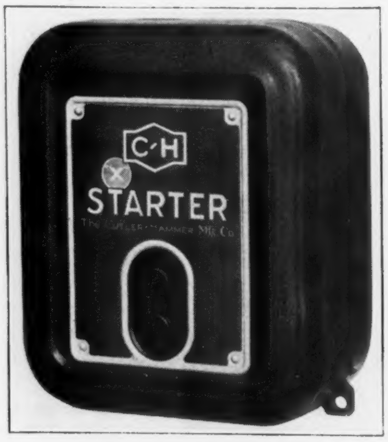
The Lincoln Electric Company announces that the Missouri district office has been moved from St. Louis to 1003 Davidson Building, Kansas City, Mr. Robert Notvest being in charge. The St. Louis district will be handled by Mr. Notvest, his time being divided between the two cities.

The company has also established a branch office at 220 Nicholas Building, Toledo, Ohio, with Mr. A. H. Homrighaus, formerly at St. Louis, in charge.

Small Across-the-Line Starter For 5 H.P. A.C. Motors

"No larger than a telephone box" is the way the new Cutler-Hammer 9586 "AAA" starter is described.

This new product handles motors of 5 h.p. and under, gives push-button



New Cutler-Hammer Starter

control of starting and stopping, provides thermal overload protection and no-voltage protection.

The starter is provided with push-buttons in the front cover of the case. The small size in most cases permits mounting of the starter where the control station would ordinarily be placed and the extra wiring and cost of a push-button station is thus saved. However, one or more push-button stations may be used if desired.

A novel feature is the type of contactor developed for use in this starter. A roller is forced between two fingers to complete the circuit. Thus a double break and a wiping contact are secured. This arrangement reduces arcing to a negligible minimum.

To adapt the starter for any horsepower within rating it is only necessary to insert the proper size heater coils in the thermal overload relay.

Chain Belt Official Passes

H. O. Seymour, director of the Chain Belt Company, Milwaukee, died of heart failure July 23rd at his country home, Lake Geneva, Wisconsin. Mr. Seymour was director of the Chain Belt Company since 1918. He was also president of the First Wisconsin Trust Company, executive vice president of the First Wisconsin National Bank, and vice president of the First Wisconsin Company, all of Milwaukee.

Atomic Hydrogen Welding Now Made Practicable

Atomic hydrogen welding — the process by means of which hitherto unweldable metals can be melted and fused without the slightest trace of oxidation, and welding can be performed in some cases on metals as thin as the paper on which this is printed—is now made practicable by the use of equipment placed on the market by the General Electric Company. This process, making possible the welding of many special alloys and the production of ductile welds in iron and steel, is the result of research conducted by Dr. Irving Langmuir of the General Electric research laboratory.

In brief, this method utilizes the passage of a stream of hydrogen through the arc between two electrodes. The heat of the arc breaks up the hydrogen molecules into atoms. These combine again a short distance beyond the arc into molecules of the gas, and in so doing liberate an enormous amount of heat, so that more effective welding temperatures can be obtained than with the usual welding methods.

Since atomic hydrogen is a powerful reducing agent, it reduces any oxides which might otherwise form on the surface of the metal. Alloys containing chromium, aluminum, silicon or manganese can thus be welded without fluxes and without surface oxidation.

Thorough trials, extending over a period of many months, were made before introducing the new equipment. The apparatus, as finally designed, represents the result of continued experimentation and research. The welding outfit consists of the following: (1) a single-phase transformer for converting the voltage of a 60-cycle source of power to one suitable for the welding equipment; (2) a specially designed, variable reactor to provide the proper welding current and voltage for different classes of work, and (3) the welding torch by means of which the actual work of welding is performed.

While the principle of operation is the same as that involved in the design announced by the General Electric research laboratory a year ago, the mechanical and electrical design has been much improved.

New Worm Gear Catalog Issued by Fawcus

A new catalog covering a new line of Fawcus worm gear speed reducers equipped with Timken roller bearings has been issued by The Fawcus Machine Company.


AMERICAN
AURORA, ILL.